DOCUMENT RESUME

ED 437 576 CE 079 668

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TITLE Innovation and Training in the Agribusiness Complex. Synthesis Report of a Study in Various Product Chains in Five European Countries. CEDEFOP Panorama.
INSTITUTION European Centre for the Development of Vocational Training, Thessaloniki (Greece).
ISBN ISBN-92-828-8366-3
PUB DATE 2000-00-00
NOTE 87p.; Written in collaboration with: W. van der Meersch, J. Denijs, A. Papadaki-Klavdianou, A. Polychroniadou-Alichanidou, A. Vafopoulou-Mastrojiannaki, K. Kruger, and R. King.
AVAILABLE FROM CEDEFOP, P.O. Box 22427, Thessaloniki, 55102, GREECE (catalogue no. HX-26-99-287-EN-C: free). Fax: 30-31-49-01-02; e-mail: dw@cedefop.eu.int.
PUB TYPE Reports - Evaluative (142)
EDRS PRICE MF01/PC04 Plus Postage.
DESCRIPTORS Agency Role; *Agribusiness; Agricultural Education; Agricultural Engineering; Agricultural Production; Case Studies; Distributive Education; *Educational Certificates; Foreign Countries; *Innovation; *Job Training; Networks; Secondary Education; Student Certification; *Technological Advancement; *Technology Transfer
IDENTIFIERS Belgium; Greece; Netherlands; Spain; United Kingdom

ABSTRACT

Part of a European project to assess the opportunities and limitations of a sectoral approach to training, this synthesis report focuses on innovation and training in the agribusiness complex. Chapter 1 discusses the study objectives, which were to gain more insight into the relationship between innovation and qualification in product chains; into the role of training agencies and other sectoral agencies in the transfer of innovations and adaptation of qualifications in product chains; and into an assessment of opportunities and limitations of sectoral training systems in situations of rapid technological change and economic restructuring. Chapter 2 highlights key concepts used in the studies. Chapter 3 gives an overview of the following product chains studied in five countries: beer production in Belgium; cheese production in Greece; bread production in Spain; vegetable production in the United Kingdom; and meat production in the Netherlands. It describes the structure of the chains and major innovations occurring. Chapters 4-7 address the following four basic issues regarding innovation and training in the agribusiness product chains: impact of innovations on qualifications; role of sectoral agencies in training for new qualifications; transfer of innovations and the knowledge infrastructure; and role of networks in innovation and training. Chapter 8 addresses five basic issues: innovation in the investigated product chains; impact of innovation on qualifications; sectoral training agencies and innovation-related training; and knowledge infrastructure in agribusiness. (Contains 18 references.) (YLB)

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Synthesis report of a study in various product chains in five European countries

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Innovation and training in the agribusiness complex

Synthesis report of a study in various product chains in five European countries

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January 1999

on behalf of
CEDEFOP – European Centre for the Development of Vocational Training

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Thessaloniki 1999

Published by:
CEDEFOP – European Centre for the Development of Vocational Training
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The Centre was established by Regulation (EEC) No 337/75 of the Council of the European Communities, last amended by Council Regulation (EC) No 251/95 of 6 February 1995 and Council Regulation (EC) No 354/95 of 20 February 1995.

A great deal of additional information on the European Union is available on the Internet.
It can be accessed through the Europa server (http://europa.eu.int).

Cataloguing data can be found at the end of this publication.

Luxembourg: Office for Official Publications of the European Communities, 2000

ISBN 92-828-8366-3

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Printed in Belgium

Foreword

In the context of its work on the advantages and limitations of the sectoral approach to training analysis, Cedefop has commissioned this report to investigate the 'behaviour' of sectoral training bodies in situations of rapid technological innovation which surpass classical sectoral borders.

Thus, the relationships between innovation and qualifications in some subsegments of the agribusiness complex have been studied. Agribusiness has been chosen as it is both highly innovative and complex, comprising the production, processing and distribution of agricultural products.

Different specific production chains in agriculture have been studied in five participating Member States: meat in the Netherlands, vegetables in the United Kingdom, cheese in Greece, bread in Spain and beer in Belgium.

In these production chains, five basic issues have been looked at: concrete innovation in each chain, impact of innovations on qualifications, role of sectoral agencies in innovation-related training, relationship between research, technology transfer and training and the role of networks in innovation and training.

In this synthesis report, the reader will notice remarkable national differences regarding innovation and its implications for the actors involved.

However, striking similarities are also apparent, such as the relationship between quality improvement and technological innovation or the power shift away from producers towards the consumers' end of line.

In all the product chains studied, the impact of innovation on qualifications is more evident in the food-processing sector where qualification requirements are generally rising and new skills for quality control are demanded from production workers. This impact is less evident in the first stages of the chains - the farms - and at the end of the chain: in the food retail sector.

Agribusiness is less 'sectoralized' than many other segments of the economy, not only in the field of education and training but also with regard to industrial relations, employment and labour market policies.

In agribusiness, knowledge is generally produced by research and development agencies, transferred by agencies for technology transfer and firm consultancy and disseminated by education and training system agencies.

The relationship between these three broad categories of agents may vary depending on various national, regional and institutional factors, but it seems that the linear model of innovations originating in fundamental research and development circuits and disseminated all the way down to education and training, is still the predominant one, although a growing flexibility and diversity of relations within the knowledge infrastructure is to be expected with various forms of networks playing an important role.

The present report has been drawn up by drs J. Warmerdam of the Institute for Applied Social Sciences (ITS) in Nijmegen, who has also written the Dutch national report.

Dr W. van der Meersch and Dr J. Denys of HIVA, Leuven, have drawn up the Belgian report, Dr R. King from the Department of Food, Science and Technology of the University of Reading is the author of the English report, and Dr K. Krüger of CIREM in Barcelona the writer of the Spanish one.

Finally, Dr A. Papadaki-Klavdianou, Dr A. Polychroniadou-Alichanidou and Dr A. Vafopoulou-Mastrojiannaki of the faculty of agriculture of the Aristotle University in Thessaloniki have drawn up the Greek report. Cedefop would like to thank them all, especially drs J. Warmerdam, the scientific coordinator, for their cooperation with this project.

Tina Bertzeletou
Project co-ordinator

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Deputy Director
Responsible for the
Research programme

TABLE OF CONTENTS

1. BACKGROUND, OBJECTIVES AND DESIGN OF THE STUDY 5

1.1 Background: previous work on the 'sectoral approach to training' 5
1.2 Major objectives of the study 6
1.3 Design of the study 7
1.4 Research questions and methodology 9
1.5 Structure of the synthesis report 10

2. KEY CONCEPTS USED IN THE STUDY 11

2.1 Sectoral training systems 11
2.2 Sectoral agencies 12
2.3 Networks 13
2.4 Product chains 14
2.5 Innovation 15
2.6 Innovation and qualification 16

3. INNOVATION IN THE INVESTIGATED PRODUCT CHAINS 17

3.1 Innovation in beer production in Belgium 17
3.2 Innovation in cheese production in Greece 19
3.3 Innovation in wheat and bread production in Spain 21
3.4 Innovation in vegetable production in the United Kingdom 24
3.5 Innovation in meat production in the Netherlands 26
3.6 Resumé 28

4. IMPACT OF INNOVATIONS ON QUALIFICATIONS 31

4.1 Impact of innovations in beer production in Belgium 31
4.2 Impact of innovations in cheese production in Greece 32
4.3 Impact of innovations in bread production in Spain 33
4.4 Impact of innovations in vegetable production in the United Kingdom 34
4.5 Impact of innovations in meat production in the Netherlands 35
4.6 Resumé 36

5. ROLE OF SECTORAL AGENCIES IN INNOVATION-RELATED TRAINING 37

5.1 General conclusion: limited sectoralization in agribusiness regarding training 37
5.2 General conclusion: limited cross-sectoral collaboration 39
5.3 Differences in the nature and pace of the innovation processes 40
5.4 Role of vocational schools 41
5.5 Role of sectoral training institutes and bodies 42
5.6 Role of companies and company networks 44
5.7 Role of networks of entrepreneurs 46
5.8 Resumé 47

6. TRANSFER OF INNOVATIONS AND THE KNOWLEDGE INFRASTRUCTURE 49

6.1 The knowledge infrastructure in agribusiness 49
6.2 The Dutch case 50
6.3 The Greek case 51
6.4 The Spanish case 52
6.5 The case of the United Kingdom 53
6.6 The Belgian case 55
6.7 Transfer of innovations through the knowledge infrastructure 57
6.8 Role of education and training 59
6.9 Development towards diversity and flexibility 60
6.10 Resumé 62

7. ROLE OF NETWORKS IN INNOVATION AND TRAINING 65

7.1 Innovation networks and learning networks 65
7.2 Relationships between innovation networks and learning networks 66
7.3 Sectoral training agencies and innovation and learning networks 69
7.4 Relevant aspects of the functioning of innovation and learning networks 72
7.5 Resumé 74

8. SUMMARY 77

REFERENCES 83

1. BACKGROUND, OBJECTIVES AND DESIGN OF THE STUDY

This study is part of a CEDEFOP project which tries to assess the opportunities and limitations of a sectoral approach to training. The focus is on the agribusiness complex. In five European countries an explorative study has been conducted, in which a subsegment of agribusiness has been studied with regard to the relationships between innovation and qualification. The starting point for these studies was specific product chains in agriculture. In the first chapter we describe backgrounds and objectives, the way the studies have been designed, the basic research questions and methodology. In the following chapter, the key concepts used in the studies are highlighted.

1.1 Background: previous work on the 'sectoral approach to training'

The studies in this report are part of a project, carried out within one of the subgroups of CEDEFOP's circle for research on trends in occupations and qualifications (Ciretoq). In the work done so far within this 'sectoral approach group', the concept of a sectoral approach to training has been investigated and assessed with regard to its opportunities and limitations regarding training needs analysis and training policy development. Furthermore, a conceptual framework for the description and analysis of sectoral training systems has been elaborated and this model has been applied in studies of two specific economic sectors in a number of countries: the printing industry and the sector of health care in hospitals. The studies in the printing industry and the hospital sector have demonstrated that the approach which has been elaborated can be particularly used as a device for analysing training policy development at sectoral level and for making comparisons between different sectors and countries. In this sense, it has made the opportunities of a sectoral approach to training more visible. Sectoral training systems might play an important role in mobilizing sectoral agencies with regard to training, organizing collective resources for training, establishing shared training policies and provisions, developing targeted training programmes for employees and the unemployed and stimulating employers and employees to take up training in a systematic way. Thus, they might contribute fruitfully to the implementation of policies of lifelong learning, adaptation of qualifications of the workforce, reduction of unemployment and the stimulation of economic growth. The synthesis reports of these studies have already been published by CEDEFOP (Warmerdam & Van den Tillaart, 1997; Warmerdam, 1998).

However, in the studies conducted thus far, some limitations of a sectoral approach to training have become visible. Limitations might occur in the developmental stage of sectoral training systems. Such systems presuppose a certain degree of common interest among the agencies involved (companies, training institutes, employers organizations, trade unions) and willingness and preparedness to establish training initiatives on a collective basis. If these

conditions are not fulfilled, sectoral training systems will meet difficulties in developing themselves. Limitations might also occur in the implementation stage. If sectoral agencies fail to implement their policies and programmes at the level of the companies they are supposed to represent, sectoral initiatives easily run the risk of dying a premature death. Further, there are some inherent limitations connected with a sectoral approach to training. Sectoral training systems are usually embedded within existing interest configurations and will undergo pressure to develop along the lines set out by dominant interest groups. Sectoral programmes also run the risk of qualifying people in a too narrow way, according to traditional sectoral borders. This might impede the development of transversal qualifications and the intersectoral mobility of employees. It might also impede economic restructuring and innovation because qualifications stick too much to the existing divisions of work. This is the main problem as there is a tendency in many occupational domains to broaden job profiles and increase intersectoral mobility. Because of these bottlenecks, we have argued in previous studies, that sectoral training systems should be embedded in broader systems and arrangements for lifelong vocational education and training. They should be connected with training systems at other levels, e.g. company level, company networks, companies' networks and supportive institutes.

1.2 Major objectives of the study

Limitations of sectoral training systems are the starting point of this study. We may presume these limitations will occur particularly in situations of rapid economic and technological change. Such developments often cross through sectoral domains and imply a fading away of traditional sectoral borders. This may require a restructuring of sectoral institutions including those concerned with innovation, education and training. The above-mentioned studies in the printing industry have provided clear examples.

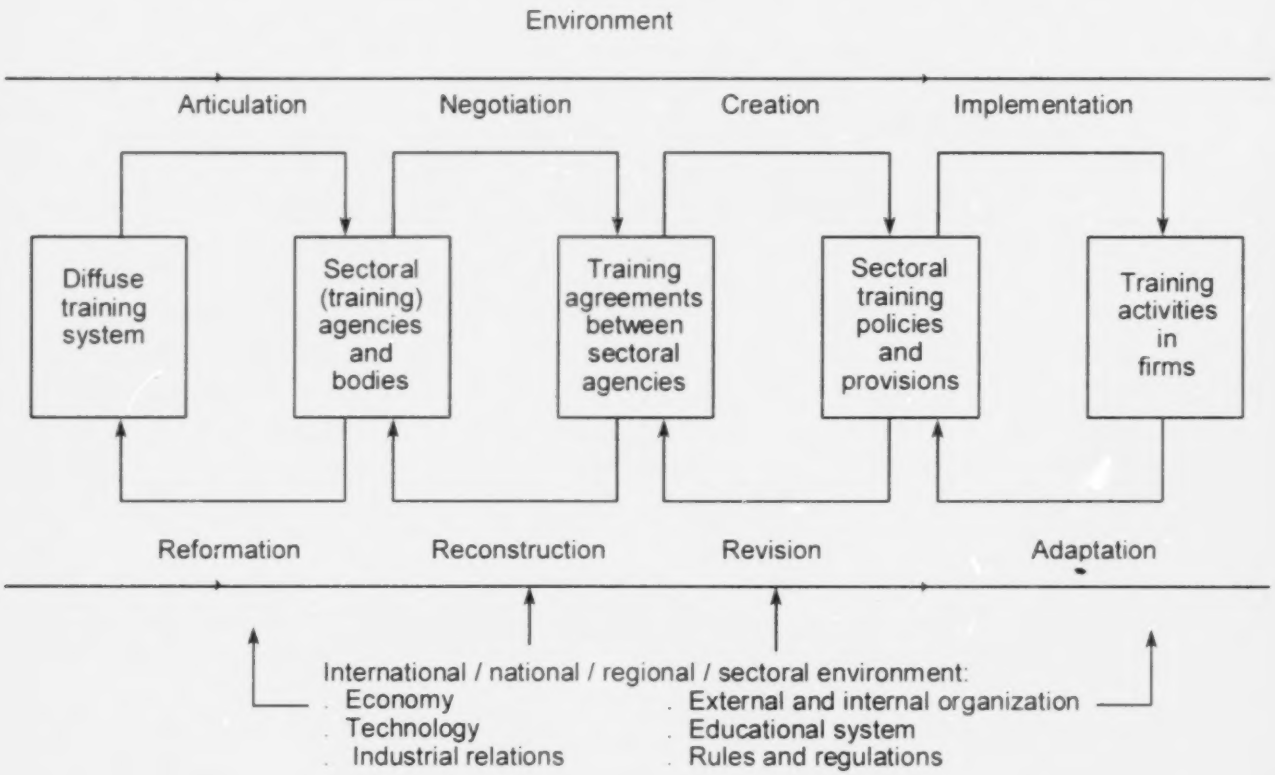
The objective of this agribusiness project is to 'test' the sectoral approach, not by looking at 'good practice' as in previous studies, but by looking at opportunities and limitations in situations where it seems less applicable in the first instance, e.g. in situations of cross-sectoral technological innovation. The agribusiness complex has been chosen as a case for this study because many innovations occur and it is an important segment of the economy and society in many countries. Another reason is it is a relatively new sector in CEDEFOP's work.

The study is not limited to one 'sector' in the traditional sense, but involves three 'sectors', which in one way or another apply to the agribusiness complex: production (agriculture), processing (food and beverage) and distribution (retail trade) of agricultural products. The point of departure of this project is not so much the 'sector' as the 'chain' of agricultural products. In each of the participating countries, a specific product chain has been chosen within which the relationship between innovation and training has been studied. The major objectives of these studies were to obtain:

- more insight into the relationship between innovation and qualification in product chains;
- a picture of the role training agencies and other sectoral agencies play in the transfer of innovations and adaptation of qualifications in these product chains;
- and thus, an assessment of the opportunities and limitations of sectoral training systems in situations of rapid technological change and economic restructuring.

Within each study, it has been possible to focus in-depth into specific innovations of particular interest to the project. In studying concrete examples of innovation, a better insight into the complexities of innovation transfer and related qualification processes can be developed.

Model of the unfolding of sectoral training systems



1.3 Design of the study

A partnership of researchers in five countries was formed consisting of: HIVA Leuven (Belgium); the department of agricultural economics of the Aristotle University in Thessaloniki (Greece); CIREM Barcelona (Spain); the department of food science and technology of the

University of Reading (United Kingdom) and ITS Nijmegen (the Netherlands). The project was coordinated by Mrs. Tina Bertzeletou of CEDEFOP.

During the first meetings of the project team it was decided that the sector of agriculture would produce interesting results if studied as outlined above. As 'agriculture' is a very broad and heterogeneous category covering many subsectors, it was also decided to focus on specific products within the agricultural sector and to take the whole 'value chain' of these products as the object of the study. For example, if meat products are the starting point then the whole 'meat chain' from the raising of cattle on farms, the processing of meat in slaughter houses and the distribution of meat products in butcher shops and superstores should be studied. The advantage of such an approach is that the spread of an innovation through the whole product chain can be followed and the impact of sectoral demarcations on training efforts may come into the picture.

In each of the participating countries, a specific although different product or value chain has been studied as it is not the intention of this study to make comparisons of the same sector between countries. It is important to gather in-depth information on some of the most important subsectors of agriculture. Criteria for the choice of product chains have been: national specialization of participating countries, importance of the product for the national/regional economy, technological innovation, crisis/restructuring processes, innovation in the context of strong international competition.

The following choices have been made:

- In *Belgium, beer* production has been studied. Both product and process innovation occur in this sector. It is interesting to look at the links between producers, distributors and consumers (horeca) and to note that economic restructuring takes place and new environmental legislation is introduced. All these processes give rise to a demand for training. Several different sectoral training agencies (for agriculturalists, operators in breweries and horeca staff) are involved in providing this training.
- In *Greece*, the *cheese* production chain has been studied, with milk production as the point of departure as it is an important product in the Greek economy with many people deployed in the sector. Many innovations occur in primary production and besides traditional products, several new products have been introduced. There is a segment of traditional, small, family-owned businesses as well as newly established larger industrial companies. Training needs are increasing. R&D and training provisions are in great need to respond to economic changes and new regulations.
- In *Spain*, the emphasis has been laid on *bread production*, in particular the production of frozen doughs. This subsector provides an example of good practice regarding training. There is a new training institute administered by the social partners which is also active in the field of research and innovation. Currently, interesting innovations in the field of product development are taking place which are having an impact on the bakery sector as a whole. There is large demand for training in catering and bread production companies.

- In the *United Kingdom*, focus has been on the *vegetable* sector. There are many links backwards and forwards across the food chain. Product innovations particularly take place in connection with the introduction of ready-made meals. Many innovations occur in food-processing companies which have an impact on the production process and jobs of the generally low-skilled labour force. There is huge pressure on R&D institutes for training and input in this regard.
- In *the Netherlands*, the *meat production* chain has been selected as this is an important branch of Dutch agriculture. Both product and production process innovation can be studied in this branch as there is an extensive R&D infrastructure. Several specialized agencies are active in the transfer of R&D results and in the sphere of education and training.

At the beginning of the project a consideration was to look at the impact of biotechnology, as being a basic innovation with probably major implications for agriculture in the future. However, it was decided to skip this idea. The implications of biotechnology thus far appear to be limited to certain specific fields and their consequences on qualifications thus far appear to be specifically important for higher and academically qualified staff. The focus in this project, however, had to be upon the majority of staff, e.g. the lower and medium-skilled workers in production, processing and distribution.

1.4 Research questions and methodology

With these product chains as the points of departure, the research questions guiding the national studies, were formulated in the following way:

- How is the product/value-chain structured? what are the main segments and how are they related/connected to each other? Which sectors and sectoral agencies are involved?
- What innovations take place? How are they disseminated through the chain? Which agencies are involved?
- What is the impact of the innovations on employment, occupations and qualifications? What changes in job profiles and qualification requirements occur?
- What does the knowledge infrastructure of the chain look like? Which agencies are involved in processes of knowledge transfer and development of qualifications? What are their main activities? How are they related to each other?
- What is the role of sectoral (training) agencies in the innovation processes, especially with regard to transfer of innovations and development of qualifications?
- How do they execute their role? What policies and activities are developed? What are the results/effects of their activities?

- What is the role of cross-sectoral and subsectoral institutions (networks!) in innovation transfer and qualification development? Are specific forms of training/learning developed by these institutions? If so, how are these connected to the activities of sectoral agencies?
- Which factors determine the role of sectoral agencies? Do they act as stimulating or hindering forces in economic transformation and innovation?

These questions provided a kind of a checklist for the design of the studies in participating countries. Within the limits of the project it was not possible to look at every question in an in-depth way. The intention was primarily to get a first, more concrete picture of the complex relationships between innovation and qualification and the opportunities and limitations of sectoral training initiatives in this regard.

For the national studies, existing literature, research reports and policy documents, etc. have been used as sources of information. Also, a number of interviews with key figures involved with innovation and training have been conducted, e.g. representatives of R&D institutes, training agencies, social partners and companies active in the sector. Besides, a kind of 'case approach' has been built in, in the sense that within a value chain one or two particular innovations were studied in more detail. For practical reasons, in two countries – Greece and Spain – studies have focused on a specific region.

1.5 Structure of the synthesis report

This synthesis report is structured in the following way.

In Chapter 2, the key concepts used in the studies are discussed. Chapter 3 gives an overview of the different product chains which have been studied in the participating countries and describes the major innovations actually taking place. In the following chapters, four basic issues regarding innovation and training in the agribusiness product chains are addressed:

- the impact of innovations on qualifications in the product chains;
- the role of sectoral agencies in training for new qualifications;
- the transfer of innovations and the knowledge infrastructure;
- the role of networks in innovation and training.

The information from the national studies is integrated into these thematic chapters. The national studies as such are not published by CEDEFOP. They are available at the institutes which have conducted the research. Their references are included at the end of this report. Taken together, the national studies provide useful insights into how innovation and training are organized within various parts of agribusiness.

2. KEY CONCEPTS USED IN THE STUDY

In this section some of the key concepts used in the studies discussed. The starting point for the research as a whole is the model of sectoral training systems which was elaborated in previous CEDEFOP projects. For the purpose of this study, however, some additional specifications are made and some new perspectives introduced. In particular, this concerns the concepts of sector, sectoral agencies, networks of agencies, product/value chains, technological innovation and the relationships between innovation and training. These new points of view, which were discussed with the research team at the beginning of the project, are clarified below.

2.1 Sectoral training systems

The point of departure of the study as a whole is a model for the development of sectoral training systems, which has been elaborated on the basis of earlier studies commissioned by CEDEFOP. This conceptual framework is presented in Figure 1.

As indicated in previous reports, according to this model, the coming into existence of sectoral institutions as a separate level for the organization of training can be conceptualized as a process of *dynamic system development*, unfolding in time through joint actions of sectoral agencies and taking place within a specific social and economical environment. This process can also be conceived as a *learning process* in the sense that sectoral agencies encounter obstacles while developing and implementing sectoral training policies and provisions and an attempt to find solutions to these problems and learn from their experiences (Warmerdam & Van den Tillaart, 1997).

With this model, it is recognized that sectoral training systems do not operate in a vacuum but develop themselves within a specific social and economical environment. The degree of interaction with the environment, however, might be different from sector to sector and might be varying in time. In some sectoral systems there might be a large degree of openness towards new developments in the environment, e.g. in technology and economy. In other sectors this might not be the case; the training systems might be rather 'closed'. An important environmental factor for certain sectoral training systems, in addition, is the existence and development of training systems in other sectors, particularly in sectors with affiliated economic activities. The degree of openness of a sectoral system towards these training systems in affiliated sectors will partly determine to what degree the system as a whole will be able to adapt itself to cross-sectoral innovations.

This points to a second characteristic of the model. Besides the environmental embededness, it also recognizes the internal dynamics of sectoral training systems once they have come into existence. It is because of these internal dynamics, we presume that sectoral training systems are able to adapt themselves to the new developments they encounter. These sectoral dynamics, however, might also execute a 'conservative' pressure and might

impede adequate adaptations. This might lead to a prolongation of sectoral policies and programmes, even in situations where traditional demarcations are no longer valid and existing policies and programmes do not any longer fit new technological and economical developments. Whether and to what degree this is the case, is a matter of empirical investigation. It is one of the objectives of this study in agribusiness to see how sectoral training systems act and react in situations of cross-sectoral innovation.

A third point we want to stress is that, for the purpose of this study, the term 'sector' is not used in a statistical way in the sense that it refers to a class of companies grouped together on the basis of certain common characteristics. Rather, it is used as a social category. It refers to a specific institutional domain, articulated by the dominant agencies working in this domain as a distinguished organizational field within which they deploy their (economic) activities. From this point of view, the domains which constitute a 'sector' and the 'borders' between certain 'sectors' and others are not defined and fixed once and for all by statistical classifications 'from outside' but are continuously produced, reproduced and eventually changed by the activities and perspectives of the agencies constituting the sectoral domain.

2.2 Sectoral agencies

As in previous CEDEFOP projects, the emphasis in this study concerning the transfer of innovations will primarily be laid on the role of 'sectoral training agencies'. However, the term 'sectoral training agencies' must not be defined in too narrow a way. In this project, the term 'sectoral training agencies' not only refers to training institutes, but also to all sectoral agencies which play some role or other in the development of qualifications and which at one time or another organize or stimulate some type of training, or broader learning in relation to innovations. In the agribusiness sector, one can think for instance of:

- agricultural universities or departments of universities who, through their research, produce basic knowledge and disseminate this to the agricultural sector by diverse methods;
- agricultural research labs and institutes, either publicly or privately financed, who conduct applied research e.g. in the field of product improvement or innovation; these institutes may also contribute in several ways to knowledge transfer in the sector;
- intermediate centres for information and consultancy in the field of new technology and its implications for company management in agriculture; these may have direct links to agricultural companies;
- centres of expertise concerning specific agricultural products;
- regional networks of companies or company owners who meet periodically to discuss new developments and exchange information on new technologies, new products, etc.

This list of agencies is neither complete nor exclusive. In different countries and sectors, different agencies might be involved depending on the precise domain of a study and on national and sectoral traditions and particularities. What has to be stressed is that all agencies which are part of the sectoral 'knowledge infrastructure' are relevant, e.g. all agencies who in one way or another contribute to the flow of knowledge in the sector especially with regard to the introduction of new technology. Of course, the 'classical' training institutes like agricultural schools or branch training centres occupy an important place in a sector's knowledge infrastructure although the focus must not be directed towards their activities alone. Important questions in this regard are: what place do vocational schools and sectoral training centres exactly have in knowledge infrastructure in agribusiness? How do they actually contribute to the production and dissemination of knowledge regarding innovations? How are their activities related to those of other 'knowledge' providers in the sector?

2.3 Networks

A second point, connected to the former one, is that we not only want to focus on sectoral agencies and sectoral training systems in this project, but also on networks of agencies which are organized on a cross-sectoral or subsectoral level. These might be networks of (public) institutes, for instance collaborating training institutes or joint bodies of training and research institutes, as well as networks of (private) companies which might also be relevant in this regard. While networks might be homogeneous and limited to a certain segment, for instance a certain type of product, they might also be very heterogeneous in the sense that they cross the borders of different segments and involve agencies from various parts of the agribusiness complex. These networks might play an important role in the stimulation of training and they might increase the effectiveness of training when connected to initiatives originated at sectoral level.

For the purpose of this study, it is particularly relevant to look at three types of networks: (a) networks of R&D-agencies and training agencies, (b) cross-sectoral networks of training agencies and (c) subsectoral networks of training agencies and companies. These three types of networks might be particularly relevant to training and learning in relation to innovation.

- Often, new knowledge originates in R&D agencies. There is a clear gap, however, between the R&D system and actual practice in (small) agribusiness firms. In many branches, separate institutes have been developed to bridge this gap. Training agencies might be part of this intermediate infrastructure. Important questions are then how they are linked to R&D agencies and how these interlinkages actually operate.
- New technologies (examples: mechatronics, multimedia) often blur sectoral borders and the establishment of cross-sectoral collaborative bodies is an instrument which sectoral (training) agencies can apply to take account of this development. For the purpose of this

study, it is relevant to look at how this process takes place, which structures for sectoral interlinking become developed, how these operate in practice and what their results are in the process of knowledge production and dissemination.

- On the other hand, the initiative can come from below. Companies can also establish networks in order to exchange information and organize training and learning in relation to new technologies. Training agencies might be part of such networks. These networks at company level should also be taken into account as one of the channels through which knowledge concerning innovations becomes dispersed in agricultural practice.

So, the network concept focuses on the interlinkages of agencies within and around sectoral training systems. Thus, the concept might lead to a more complete analysis of the dynamics of the systems, e.g. the activities of central agencies, that act upon new developments they encounter in a more or less coordinated way with agencies in their environment and by establishing such coordinated policies, might succeed in overcoming some of the inherent limitations connected with a merely sectoral approach to innovation-related training.

2.4 Product chains

As indicated before, specific product chains in agribusiness are the focal points of this study. The concept of product chains refers to a different way of grouping companies together than the sector concept. If we look at the economic activities on which classifications are based, we might say that the product chain concept groups companies together in a more 'vertical' way, whereas the sector concept groups companies together in a more 'horizontal' way. In a 'chain' a certain product is the starting point for classification and the different steps in the production process are the rationale behind the grouping together of companies. All types of companies which in one way or another contribute to the production of a certain product, including its distribution on the market, are considered to be part of the 'chain'. The product chain crosses through various economic segments, which are usually separated by markets. A product chain consists of companies with different types of activities (suppliers of primary products, goods manufacturers, distributing companies, wholesalers and retailers, etc.). With the sector concept, on the other hand, companies with grossly the same type of activity are grouped together. Here, comparability regarding products and markets are usually the main criteria for classification. Product chains and sectors criss-cross each other. Product chains might cross through different economic sectors. Sectors might encompass segments of different product chains.

Thinking in terms of product chains is a recent trend in the agribusiness complex. The complex is strongly market-driven and there is a tendency to develop backward connections within product chains, for instance connections of retail firms with food processing companies and, further backwards, of food processing companies with suppliers of basic agricultural products. These connections within such product chains primarily have economic functions, like just-in-time delivery of basic products, assurance of basic product quality or provision of

adequate varieties of basic products. An important question in this study is what kind of opportunities these economic connections between firms in different segments of a product chain can provide in the field of training and learning (cf. King & Kruse, 1996).

As indicated before, product chains in agriculture normally encompass three basic segments, e.g. the production, processing and distribution of agricultural products. For the purpose of this study, these three segments are considered as separate (broad) economic sectors. In this sense, the study is cross-sectoral. It is focused on these basic sectors and particularly looks for training and learning initiatives which cross traditional borders between these sectors. It does so by studying specific product chains. The question of how cross-sectoral initiatives are linked to traditional training initiatives within the basic sectors is particularly relevant for the study.

2.5 Innovation

At the start of the project it was decided that the concept of innovation will be used in a broad sense in this study. In documentation, different types of innovation are distinguished, such as product, production process, machinery and equipment, organizational structures, work processes and management and control systems. Besides innovation, the term 'modification' is also often used to refer to changes in combinations of knowledge, methods, materials, techniques and labour force. Because of the focus on product chains, it was decided to take 'product development', e.g. the introduction of modifications or innovations in the final products themselves, as the major point of departure. Product modifications or innovations, however, might of course lead to innovations in production methods and processes, work organization or management systems. Where this was the case, these implications were taken into account.

An important criterion for the selection of the modifications/innovations to be studied, was their potential impact on jobs and qualifications. Primarily, product innovations have been selected which were presumed to give rise to clear changes in work processes, in the content of jobs and in qualification requirements, so that training activities could come into the picture. This study is not a study into the innovation process as such, but into the relationships between innovation and training, e.g. between the transfer of innovations and the development of (new) qualifications through training and learning. However, some attention has been paid to the impulses for innovation. Where did they come from? Did they come from market pressures, (new) legal regulations, technological breakthroughs, international corporations, etc.?

The starting point for research into the transfer of technological innovations is often a rather *linear model* of the innovation process (cf. Berkhout, 1996). According to this model, innovations originate in R&D circuits. Here, they are often also applied, tested and elaborated further in certain products, which could have a commercial value on the market. Next, these applied innovations are introduced into a number of companies, which are ahead in the

sector. If this turns out to be successful, they gradually become dispersed into the majority of companies in a certain branch. Different agencies, like R&D institutes, research laboratories, consultancy firms, training centres and companies themselves are involved. Each of them plays a specific role in the different stages of the process.

However, there is a lot of debate going on concerning the limitations of such a linear or sequential conceptualization of the development and dissemination of innovations. In this debate, more attention is asked for the *interactive aspects* of innovation and for all kinds of feedback mechanisms between different agents and stages in the development and distribution process. According to recent views, 'innovation' not only takes place in the 'technical system', i.e. in R&D institutes, but it may also originate on the market itself, from initiatives of practitioners active on the market. In particular, innovations of a less fundamental kind might have their origin in companies or groups of companies, which apply certain technologies, processes and products. Also, engineering and consultancy firms, sometimes together with companies, might contribute to the further development of new technologies. Exchange of information through specific joint bodies may provide feedback from the market towards the agencies responsible for fundamental and applied research. In this sense, it is argued, research and development comes under the influence of market forces. Demands from customers and practitioners (companies, engineering firms, consultancy firms) tend to give more impulses towards fundamental research and product development. Interaction between producers and consumers of knowledge tend to become more important (Berkhout, 1996).

In many instances we believe a linear model will still be adequate to analyse innovation processes in agribusiness. But, in this study we also want to have an eye on the feedback mechanisms between the different stages in innovation. These mechanisms, which are seen in the connections and interactions of different agencies in the innovation process, can provide special opportunities for the stimulation and organization of training and learning.

2.6 Innovation and qualification

Applying these two models of innovation to the question of what role sectoral training agencies in innovation processes can play, we can say that this role has to be looked upon in a double way. Principally, the relationship between qualification and innovation can be conceptualized as two-sided. Sectoral (training) agencies can play a *reactive role* in the transfer of innovations in the sense that they provide employees (or newcomers to the labour market) with adequate qualifications in order to adopt and use new technologies. But, in principle, they can also play a more *proactive role*, in the sense that they equip employees not only for a 'passive' adoption of innovations but also for anticipation of and even active participation in innovation processes. This requires specific arrangements between training and innovation agencies. Where such arrangements were observed, they received special attention in national studies.

3. INNOVATION IN THE INVESTIGATED PRODUCT CHAINS

In this section, we will give an overview of the product chains investigated in the national studies. The structure of the chains and a number of its basic characteristics will be described. We will discuss the major innovations taking place, the main forces behind them and their implications for the actors in the field. In the next section, we will continue with an analysis of the impact of innovations on qualifications in the product chain. The sections are based on the information delivered in national reports.

3.1 Innovation in beer production in Belgium

The Belgian study focused on the brewery sector. This is the largest branch of the Belgian drinks sector, both in turnover rates and in terms of employment. The brewery sector deploys nearly 60% of the total workforce in the drinks sector. There are some 90 brewery companies with about 6 800 employees. The sector is highly concentrated. Nearly 50% of employees work in the four largest breweries; one third of them only in the one leading Belgian brewery.

The breweries have to cope with several changes on the market. Internal markets have become saturated during the past decade, resulting in severe price competition and foreign markets have opened up and export opportunities have arisen. Consumer behaviour has become more and more selective leading to a need for companies to specialize and introduce new types of beers. There is a growing concentration of the retail sector, which now forms a real market block towards the breweries. The breweries react upon these market tendencies in several ways. Main strategies are the development of national or international premium marks, higher investments in marketing and sales and saving money in production and distribution through standardization, specialization, modernization and innovation of labour organization.

The process of the beer production chain can be broken down into three major parts:

- production of basic ingredients;
- brewing process and distribution;
- selling of the product in the horeca.

The Belgian study discusses innovations in these segments based on a case study at the leading brewery. Large breweries are 'the true innovators in the brewery sector', concludes the Belgian report. The investigated brewery is highly innovative and further stimulates innovations both backward and forward in the product chain.

The first stage in beer making is the production of basic ingredients. Basic ingredients for beer are: water, grain, hops, malt and yeast. Important actors at this stage are farmers who

produce the grains and the hops for breweries. Innovation at this stage is limited to the cultivation of basic ingredients. According to the Belgian report, there are important links between breweries and the farmers: *'Indeed, farmers are selling their products to breweries according to specific criteria. The breweries draw up a list of deliverers (farmers) each year and award each deliverer a score. This score is later handed over and explained to deliverers to give them feedback on the quality of their products. This process or contacts is based on tradition. The most important conclusion for this step of the production process is thus that the breweries play a central role in the production process of basic ingredients. Farmers have to innovate their production process to respond to new demands. Therefore they have to experiment with new techniques'*. So, the breweries primarily stimulate innovation in the first stages of the product chain.

The second stage is the brewing process itself, the core process of beer making, which is organized in industrial brewing companies. The process can be divided into the following steps: malting, brewing, fermentation, spontaneous fermentation, maturation, filtering and bottling and storage. As stated before, brewing is highly concentrated in a small number of large breweries. So, innovation at this stage is for a large part an in-company affair and regards both product and production process technology. The investigated beer company – market leader in Belgium for several well known beers – recently has constructed a new, fully automated department for beer production. The Belgian report concludes: '*Growing competition at national and international levels forced the company to automate their production. Because it was difficult to innovate solely the production department, the management took the option of complete automation of the production process. With this system, production costs were reduced, less personnel was needed, faster delivery times were made possible and production was made more efficient and effective. Four important innovations were introduced in that perspective: a completely computer-guided production hall, a new filtration process, a new line for conditioning and finally a renewed storage and distribution system*'. As a consequence, there was a need for higher qualifications of the workforce.

Most innovations in the brewing process occur in the large Belgian breweries, which in turn are inspired by even larger international breweries. According to the Belgian report, there is a kind of 'cascade' process going on with regard to the dissemination of innovations. They originate in the research centres of the large, global companies, then spread to the large Belgian companies in the form of adaptation of new technologies and production techniques. Here, producers and deliverers of machinery often act as disseminators of innovations. And, finally, they enter the smaller, specialized and sometimes old-fashioned Belgian breweries.

The third part of the chain is the hotel and restaurant sector, for the breweries already a part of the consumer market. A lot of distribution to the horeca is carried out directly by the breweries without the use of intermediaries. Cooperation between breweries and these selling points is based on the breweries specifically investing to improve the quality of horeca management. As far as innovations occur in this sector, they primarily have to do with modernization of the outlets.

3.2 Innovation in cheese production in Greece

As the Greek report states, the agricultural sector was, is and always will be an important sector of the Greek economy. Agriculture contributes 21% to total employment in Greece and 16% to the Greek GDP.

In Greece, the cheese production chain has been studied, with special reference to the situation in one of the most well known and typical Greek cheese producing regions, that of Ipiros. Sheep and goat breeding is well extended and the mountainous character of the region was a main factor stimulating the development of small ruminant breeding. The cheese sector was further developed by the establishment of the first practical dairy farming school before the Second World War and the foundation of a 'model' cheese plant shortly after the war. These institutes provided for growth of a labour force adequately qualified for cheese production. The cheese sector was further stimulated by the commercial relationships of the inhabitants with neighbouring Italy, a large consumer market, that created an interest in new types of cheese. Actually, approximately 14% of the total quantity of Greek cheese is produced in Ipiros and three of the 10 largest dairy industries in Greece are also situated in Ipiros.

Cheese is a main element of the Greek diet. It represents about 46% of the total consumption of dairy foods and 7.5% of total food consumption. More than 60% of cheese consumed is soft cheese. A very large proportion is sold unpackaged. However, the proportion of prepackaged products is growing because of increasing quality demands of customers, more offers of standardized products by the large cheese industries and supermarket requirements, which for a large part have replaced grocery stores as the major selling points.

The Greek cheese sector has a very long tradition of craftsmanship. At the moment, it is still dominated by small and medium-sized enterprises which are usually family owned. At the end of 1994 there were 727 cheese plants. More than 62% of them have an annual production of less than 100 tonnes, while 37% produce 100-1000 tonnes per annum. However, the number of SMEs is continuously diminishing in favour of the larger plants. Between 1989 and 1995 the number of small plants (<100 tonnes) decreased by 37% while the number of larger units (100-1000 tonnes) rose by about 25%. Actually, the larger cheese producers, forming 1% of the companies, produce about 27% of all cheese. In fact, the sector is now divided into two segments: the small traditional, family-owned cheese makers and the larger industrial plants, usually located in the more populated regions.

The basic ingredients for cheesemaking come from sheep and goat breeding. Approximately 250 000 families are involved in sheep and goat breeding, which usually takes place in small flocks in mountainous and semi-mountainous areas. There is continuous pressure on these farmers, if they do not succeed in making an adequate living, to leave the rural regions and go to the cities. As the Greek report concludes: '*The cheese sector, using milk from small ruminants, has therefore a major economical and social significance*'.

The cheesemaking chain consists of three major parts:

- sheep and goat breeding;
- cheesemaking;
- distribution and placing on the market.

The cheesemaking process itself can be divided into a number of substages which have to do with the processing of milk (reception, standardization, heat treatment), the transformation of milk into cheese (acidification, curd making and cutting, whey separation, scalding, moulding, pressing, brining) and the handling of the cheese (ripening, washing, packing, cold storage). Many innovations have been introduced in cheesemaking during the past decades. New government legislation and programmes for development financed by the government and the EU have played an important role regarding innovations, as they often were the driving force for the introduction of new technology. The Greek report mentions, in particular, innovations in the following fields:

- improvement of genetic material of animals leading to great progress in milk quantities, composition and milking procedures;
- improvement of animal feeding, reducing morbidity and mortality rates and increasing productivity;
- introduction of machinery and equipment for milking, cooling, analysis and milk processing;
- improvement of hygiene at all stages of milk making;
- reorganization and modernization of businesses by making use of national and EU development programmes.

Some of the EU directives and regulations for milk production contain specific rules regarding the qualifications of employees, such as Directive 92/46/EEC which within the framework of other hygienic rules prescribes that '*firms must ensure staff are trained to enable compliance with conditions of hygienic production*'. Application of EU regulations have given major quality impulses in Greek milk and cheese production.

As a consequence, during the past decades cheesemaking has strongly evolved in Greece. The Greek report states in this regard: *Cheesemaking has been an art handed down from generation to generation to satisfy regional needs and demands....The progress of cheesemaking is due to the progress of science and technology...cheesemaking from simple art became art and science....Although cheesemaking retains its traditional character, the installation of new large cheese plants and also the introduction of some large dairy industries into the cheese sector made it more dynamic and offered a potential for further development'*. The case study of the region of Ipiros illustrates very well the central place these large cheese plants occupy in the regional economy and the local communities.

New developments have changed the structure of the Greek cheese sector substantially. They have resulted in a division of Greek cheese production into three types of companies: the sheep farmers, usually family-owned businesses in mountainous areas which introduce more and more new techniques in traditional breeding processes; the small cheese plants, usually situated in the milk production area near the farms where they collect milk and which have often little access to existing innovation networks; and the large dairy industries located near the big cities with modern company structures and an often highly qualified staff. These organize innovation partly within their own research departments.

3.3 Innovation in wheat and bread production in Spain

In Spain, the wheat and bread production chain was selected for the study. The study focuses in particular on an innovative branch within the meal and bakery industry, e.g. the production of frozen doughs which also represents a kind of 'good practice' regarding innovation-related training. The major companies active in this branch are located in the region of Catalunia which is why Catalunia was chosen as the focal point of this study. It is one of the Spanish regions with a long industrial tradition, located near the border, having important harbours and having established many commercial relationships with other countries in the past. This is also expressed in the bakery sector.

As in many European countries, agribusiness in the whole of Spain is characterized by a continuous loss of weight in the labour market, caused by mass destruction of employment in agricultural work. The contribution of agricultural production to the GDP dropped down from 5.9% in 1985 to 3.4% in 1994. In the 1990s a process of concentration began, which has led to the disappearance of a large number of holdings, an increase in the average holdings size and a considerable decline in employment. In 1995, the agricultural sector deployed 9.2% of the total number of workers.

Typical for the agricultural sector is its ageing population, the large number of employers without personnel, self-employed workers and the generally low education level of the farmers. There is also an important exodus form rural areas. The foodstuffs sector also contributes significantly to GDP, but this sector is also losing ground, from 5.3% in 1986 to 4.4% in 1992. Here, there is a clear predominance of small businesses, with less than 20 employees (92% in 1992). The sector deploys 3% of the total workforce. There are less illiterate and uneducated employees than on average in Spain.

The education level of the workforce is gradually rising, due to a reduction of unskilled labour. In the retail sector, a major trend is the decrease of the number of small, traditional outlets. There is a clear tendency towards hypermarkets, whose share in total sales rose from 18% to 30% between 1988 and 1993. The Spanish report concludes that in general '*the powerful foodstuffs industry has become a key sector in the production structure of the Spanish economy*'.

The central product chain of the study is frozen dough products, based on wheat and flour. The major segments in this chain are:

- wheat farms,
- wheat suppliers,
- milling plants,
- frozen dough bakeries,
- outlets (distribution).

At the beginning of the chain a number of suppliers of basic ingredients can be identified such as seed R&D centres, seed producers and producers of fertilizers. At a later stage in the chain, milling plants are supported by both supplier firms (additives) and the frozen dough bakeries. Their major suppliers provide for instance, eggs, milk, chocolate and other sweet preparates.

Wheat agriculture is one of the major segments of cereal production. Its proportion has grown from 27% of total utilized agricultural area in cereal growing in 1990 to 32% in 1995. The cereal segment has experienced an increasing internationalization in the 1990s – both imports and exports have grown.

The milling segment was confronted with important technological and economic changes in the 1960s. Development of road transport lead to a technological revolution in industrial milling. In the 1970s a restructuring plan for the sector was implemented by the government leading to a close down of approximately 1000 plants and a strong growth in productivity. In the 1980s another 400 industries had to close down. During this period of crisis and severe price competition, new products were introduced to the market based on wheat flour and other cereals flour or flour derivative products. At the moment, there are 281 flour producing plants with about. 2 800 employees. Almost 75% of them are manual workers, many of whom are older workers with only little formal education. Of all meal produced, 67% is used for plain bread, 33% for other products, such as biscuits, industrial bread and pastry products; 4% is used for frozen doughs. The export rate of meal has risen from 1% in 1985 to 15% in 1995. This illustrates the growing internationalization of the sector.

An important factor stimulating the internationalization of both wheat and meal production was the opening up of the economy after the death of Franco in the 1970s and the accession of Spain to the European Community in the 1980s.

Most plants of frozen doughs are located in the region of Catalunia. Frozen doughs are semi-processed products, used by different types of industries or plants which transform them into a finished product: bread and pastry based, frozen or precooked doughs, which are commercialized on their own or with fillings and icings. They are not produced in traditional bakeries but in industrial plants of a larger or smaller size. According to the Spanish report, there is actually a distinction in bread production between three major segments: industrial breads, frozen doughs and traditional breads: *'Frozen doughs can be seen as somewhere in*

between industrial bakeries (qua production style) and traditional bakeries (qua sales structure). Frozen doughs are distributed both through specialized outlets and shops as well as through large supermarkets and food hypermarkets'. Frozen doughs production is one of the most dynamic segments of the bakery industry, with a sharp growth in production (from 3 tonnes in 1985 to 120 tonnes in 1994) and still more growth forecast in the years to come. In particular, growth is expected in hotel and restaurant consumption. In 1995, there were 28 firms producing frozen doughs with 1300 employees. The five leading firms control 60% of the market. Most of the leading firms are based in Catalunia.

The production of frozen doughs is a rather recent activity in Spain. According to the Spanish report, manufacturers of frozen doughs have been the major promoters of change along the wheat and bread production line. They represent in a typical way the new trends towards industrialization and specialization in the bakery sector and the implications these processes have in the different stages of the product chain.

These trends will have an impact on agricultural wheat producers as they are the major suppliers of milling plants and industrial bakeries. The report states: *'An adequate system of wheat selection according to quality criteria is necessary. The system now fails. In the middle term, it can be foreseen that the diversification of bakery products whose production requires specific flour types, will generate and has actually generated an increased demand for quality in milling plants, which would in turn be transmitted to wheat farmers and suppliers, from whom greater wheat quality and varieties and improved selective wheat harvesting would be required.'* In fact, this is a general problem in Spain. There is no adequate system of suppliers' quality control. Experts stress the necessity that it should be implemented.

The impact on the milling plants themselves will be less radical. *'The quality element also takes specific shape in the growing introduction of advanced quality control systems which cover the whole milling process from the time the raw material is received to storage'.*

Some implications on the bread production process are already visible. The report mentions some of the consequences of the rise in bread production plants: a growing industrialization of bread production; a larger degree of work division; a detachment at local level of bread production from selling the bread in the outlets; some loss of professionalism among the workforce; a growing importance of quality control and health regulations. Another effect can be foreseen in the traditional bakery sector: *'a renewal of traditional bakeries by diversifying their products and modernizing their establishments and investing in new equipment and machinery'.* This might lead to a growing demand for training in traditional bakeries.

Finally, there is an impact on bread distribution: besides production price and bread quality, the role of outlets becomes increasingly important in competition. Outlets have been modernized (*'friendly, clean, bright, decorated and smells of bread'*) and have introduced special services like tasting services and cafeterias within the outlets.

With regard to the impact on commercial relationships among different suppliers, the Spanish report concludes that there is still free trade between dough manufacturers and milling plants, but that between milling plants and wheat farmers more stable relationships have been

developed *'to obtain the desired wheat quality level'*. This is an incipient trend, particularly visible in some regions although it is not the dominant practice. However, relationships between milling plants and wheat farmers are moving towards intermediate patterns between free trade and organisational integration. This means more exchange of information across the product chain, but what this might imply for training is not yet clear. According to a Spanish expert *'this is not a relationship between equals...the farmers are in the weakest position and have to bear all the pressures'*. First and foremost, it appears to be merely a commercial relationship.

3.4 Innovation in vegetable production in the United Kingdom

In the United Kingdom, the fruits and vegetable sector has been studied, in particular the product chain of prepared vegetables, with the case of prepared salads as a specific example. The prepared food market is a growing market in the UK, as in many other countries, at the cost sometimes of the fresh fruit and vegetables market. The UK report mentions a number of important changes in the fruit and vegetable sector, which affect production and distribution processes and the relationships between the actors involved. Many changes are the result of growth of the market share of supermarkets. The large retailers actually account for over 50% of the fruit and vegetable market. The sector therefore has become strongly 'market-driven'. Major trends in the market are:

- globalization of the market and extension of the season by global positioning of the production of fresh vegetables;
- the rise of the prepared vegetable sector, among others as a reaction to the growing demand of customers for fast food;
- the strengthening of supply chain relationships between retailers and producers, e.g. the development of vertical as well as horizontal alliances along the food chain;
- growing interest of consumers in healthy food and vegetarianism and the resulting stronger quality requirements and regulations introduced by supermarkets.

These trends are strongly supported by technological innovations which have been introduced in the sector. The UK report distinguishes three basic categories of innovations: product, process and organization and management. As the food industry is strongly market led, it is stated, *'new product development is often directed towards adding value to products as exemplified by the development of ready prepared meals'*. In 1995 for instance 4 600 new product launches were recorded within the frozen, chilled and ambient grocery sector. *'Process innovation'*, it is reported: *'is generally concerned with reducing production costs or the production of new products. Flexibility is again a key feature of these developments along with the already well established trends in computerization, instrumentation and control which pervade all aspects of food processing through production, storage and distribution'*. The report further stresses the importance of organization and management innovations which

primarily are directed towards an increase of flexibility at firm level. Many innovations in all three fields were particularly stimulated by the development of microelectronics and computer technology, for instance to be used in measurement instruments (sensor technology), equipment for the control and steering of processes, storage and distribution techniques and intra- and intercompany information systems.

In the 1990s, on the UK food market, consumers have increasingly turned towards prepared food. As a result, in this segment many new sophisticated products have been designed, reflecting customers demands for more convenience and quality. Specifically, the restaurant market is addressed in this regard by food producers and retailers. The report states: '*The development of the prepared food market is an area (..) that is the focus for much innovation along the food chain. Marketing pressures and safety concerns are resulting in innovation in product development, technology and work practices*'. The prepared salad market – a subsegment which expands very rapidly – is analysed in more detail in the UK report as an example to illustrate this tendency.

Two major groups of prepared salads can be distinguished: wet salads and dry salads. A typical product chain of prepared salads encompasses the following stages:

- harvest of produce;
- produce distribution and storage;
- trimming and cutting;
- washing and drying;
- mixing of salads;
- packing;
- storage and distribution.

As the UK report states the production process requires high quality standards and new technology supports this: '*The nature of the processing steps are intrinsically simple: washing, trimming, cutting and packing. However, to achieve the desired self life with the required product quality and safety, and at a profitable production rate, there are many technological issues that need to be addressed.*' All kinds of variables have to be monitored and controlled carefully in order to provide quality and safety of the final product. Quality monitoring starts already with crop production and harvesting (use of fertilizers, cleanliness of the plant, way of harvesting) and goes on in the processing, storage and distribution phases. Atmospheric conditions, like oxygen level, respiration, humidity, temperature level, etc. continuously have to be controlled in order to prevent deleterious changes and physical damage to the produce. The UK report stresses that for this reason in salad production supply chain relationships have been well developed: '*To run successfully this process, a high level of cooperation is required along the food chain, from farm to mouth, as actions taken at any stage can materially affect both quality and product safety. The processors have long-term relationships with both their suppliers and customers.*'

The demand for prepared salads has increased considerably in recent years. Many product varieties are launched each year by supermarkets. A number of food processing companies have specialized in the supply of dry prepared salads. These companies link vegetable and salad growers with the supermarket chains. In practice, collaborative relationships have been developed between these companies and a number of horticulturists, which also implies the (mutual) exchange of personnel. The UK report points to the qualifying function of this exchange of staff: '*Trained horticulturists from various suppliers undertake short periods of secondment in a factory. They see all aspects of the processing and work on the production line. Thus, they are able to see the importance and significance of product specification and appreciate the level of waste resulting from out of specification produce. Exchanges in the opposite direction also take place. Manufacturing personnel work in the field so they can appreciate the problems of providing the factory with what it wants*'. In this way, a better mutual understanding of the conditions of growing and respectively manufacturing is stimulated across the beginning of the product chain. At the other end of the chain, the relationships between processing companies and retailers are more exclusive. Often, a processing company works for only one or two supermarkets which take most of the company's production. Here a practice of auditing has been established. Retailers audit their major suppliers particularly for product safety and quality. Supply chain management also works in this direction.

3.5 Innovation in meat production in the Netherlands

In the Dutch case meat production has been studied in more detail, especially pig meat. Meat producing farms make up almost 60% of all farms; there are some 70 000 meat production farms out of a total 113 000. Meat processing companies are, after the bread and biscuit sector, the largest segment of the Dutch agricultural industry. There are 750 slaughterhouses and meat processing companies with circa 21 000 employees. Wholesale and retail trade in meat and meat products account for about 7 500 shops which deploy nearly 40 000 employees. The meat production sector in the Netherlands, especially pig production, is in severe crisis at the moment as a consequence of overproduction in the past, shifting consumer demands towards higher quality standards, inability to meet environmental legislation and heavy criticism from the public and ecological movements. As a reaction to a severe epidemy that hit the pig sector this year, the government has recently launched a plan for a forced reduction of the sector by about 25% in the short term. The sector has already been in trouble for some time. This is one of the reasons why thinking in terms of the 'agrochain'- concept, with its related notions of supply chain management, added value and product quality has been well received in the meat sector.

The pig meat production chain consists of the following types of companies:

- pig breeders;
- pig dealers;

- pig farmers;
- slaughterhouses;
- meat processing companies;
- meat dealers;
- butcher shops.

To these major groups of companies are sometimes two others added, one at the beginning of the chain, e.g. the producers of pig food, and the other at the end, e.g. companies specialized in the processing or recycling of slaughtered animals' waste. Besides these major groups in the 'primary process', some supportive services are also involved, such as inspection services, veterinary surgeons and transport service companies. The meat chain can be further divided according to type of animal. In the Netherlands the major subchains are cattle, pig and poultry production.

Innovations in Dutch meat production are influenced by a number of specific factors: the tendency of increase of scale and specialization; growth of meat processing companies; a stronger orientation towards durable agriculture and nature conservation; a stronger orientation towards market-oriented production and a greater interconnection with international developments. A recent report of Dutch research organizations in agriculture (NRLO) summarizes the most relevant innovations in animal production. They occur in fields like:

- biotechnology (e.g. animal transgenesis, improvement of reproduction technology);
- physiology (e.g. improvement of animal food products and production);
- measurement technology and instrumentation (e.g. biosensors, new scanning technology);
- information technology and simulation techniques;
- environmental protection technology (e.g. new energy sources, handling of waste);
- packaging and conservation technology;
- medical-veterinary technology (e.g. better vaccination techniques);
- communication technology (e.g. use of multimedia communication).

The report concludes that in the long run innovations will provide the animal production sector increasingly with new chances for combining economic demands with ecological values in the sphere of environmental protection, animal health care and quality production.

Especially in pig meat production, quality improvement and improvement of animal health care will become major driving forces behind innovations in the future. Both fields are interrelated, as the NRLO states: *'Animal health care has to be embedded in systems of quality management and these, in their turn, have to be organized on a cross-company level, e.g. on the level of the product chain'*. On this level requirements concerning animal health

care should be defined and monitored, with the aid of new information systems in the different stages of production. This illustrates the prevalence of agrochain thinking, which is strongly promoted in the Dutch agrofood industry. Pressure towards improvement of 'animal wellbeing' has strongly promoted this kind of thinking. Pressure came from the government, which tries to limit further growth of large-scale pig 'factories', from consumers who have become increasingly aware of the negative consequences of 'animal stress' on pig meat's quality, and from the ecological movement which acted heavily against the negative circumstances for animal life on pig farms and against the pollution caused by large-scale industrial pig farming. Demand for ecological meat products has increased strongly during the past years in the Netherlands. Large supermarkets increasingly provide 'green' makes on their shelves, e.g. meat products produced on an ecologically acceptable and 'animal-friendly' basis.

In a certain sense, the other new technologies mentioned above might contribute to the improvement of animal health care and quality production. However, in recent discussions pleas are for a more far-reaching strategy. Product and process innovations, as those mentioned above, are no longer deemed to be adequate to tackle the severe problems agriculture is facing and the increasingly differentiated market demands. One is opting for more fundamental changes in the form of so-called 'system innovations', strategies aimed at restructuring the agribusiness complex in an entirely new way. According to a recent scenario study of the NRLO, the sector is in need of new, innovative network forms of organizations: *'In this context the future is not for (vertical) chains, but for a conglomerate of responsive, flexible organizations which will continuously establish new (vertical, horizontal and diagonal) alliances'*. How such structures will be developed in practice, will depend partially upon developments at company level. Much greater heterogeneity is foreseen within the sector (large-scale 'farm factories' alongside small-scale ecofarming, for instance). It is recognized that such a fundamental restructuration of the production system would also have major consequences for the knowledge infrastructure.

3.6 Resumé

In conclusion, we might say that there are remarkable differences between the product chains described with regard to innovations and their implications for the actors involved. Differences regarding innovation have to do with different national traditions, different technological, economical and sociocultural environments, different structural positions and different relationships between the major actors in the product chains. The primary driving forces behind innovation also appear to be different in the different countries/product chains:

- in Belgian beer production, e.g. (international) competition together with organizational efficiency appear to be major drives to innovate production systems;

- in Greek cheese production, a combination of push-factors from science and technology, governmental legislation and support schemes and the establishment of industrial agrofood industries appear to have had major effects;
- in Spain's bread production, the concentration process and resulting economies of scale, the import of new products from abroad and establishment of modern industrial bakeries have had an innovative effect on the sector as a whole;
- innovation in the vegetables production sector in the United Kingdom is strongly influenced by market trends and changes in consumer demands towards more quality products;
- in the Dutch meat production sector, besides strong market influences, ecological pressures and government actions towards economic restructuring are strong drives for innovation.

However, besides the differences (which have only slightly been touched here), striking similarities become visible. One important similarity is the relationship between quality improvement and technological innovation, which is evident in all the investigated sectors. Many innovations cause quality aspects of production, processing and distribution to come more to the front in the different product chains. Secondly, the strengthening of relationships between different actors within the chains is a clear similarity, whether or not this is explicitly organized under the parapet of supply chain management. There are differences in the power structures within the chains. Sometimes supermarkets are dominant, such as salad production in the UK. Sometimes processing companies are dominant, such as beer production in Belgium and cheese production in Greece. And sometimes retailers and processors are rather balanced, as in bread production in Spain and meat production in the Netherlands. In every country/sector, however, a tendency towards a reversal of chain dominance appears to be taking place. Everywhere power is shifting away from the producers towards the consumers.

4. IMPACT OF INNOVATIONS ON QUALIFICATIONS

In this section the impact of innovations on qualifications in the product chains, described in the previous chapter, will be discussed. Primarily, we will focus on changes in qualification requirements for the core occupations and jobs in the chains in all three segments: agricultural production (farming), agricultural industry (food processing) and distribution of agricultural products (retail trade). We will try to assess as much as possible both the changes for entrepreneurs and management as well as the changes for workers. As in the previous section, the discussion is mainly structured according to the information provided by the national reports.

4.1 Impact of innovations in beer production in Belgium

The impact of innovations in the first stage of beer production, the production of basic ingredients – mainly grains and hops – appears to be rather limited. Innovation here, takes the form of better cultivation of basic products in order to supply the breweries with uniform quality according to the required specifications. Farmers have to experiment with new cultivation techniques (use of new types of fertilizers) and therefore they should learn about them. This learning process goes on in a rather informal way, as we will see in the next chapter. It is mainly a process of trial and error sometimes supported by the breweries and carried out within small circles of hops farmers, who mutually exchange experiences and thus learn about new techniques and procedures.

Innovation in the second part of the chain, the brewing process, has more severe implications for qualifications, both at management and workforce levels. The case study in one of the large Belgian breweries describes how new management strategies aimed at strengthening the position of the company on international markets require an increase of scale, greater cost-efficiency, harmonization of the product range and further standardization of production equipment and processes. Recently a new fully automated beer production department was installed and the whole labour process was reorganized. The new automated production system caused a need for a higher qualified workforce. Where operators in the old factory needed a high-school qualification, e.g. an A4 or A3 certificate, operators in the new factory must be able to offer at least an A2 certificate. The job profiles of several groups of workers in the production unit became broader: to include new tasks such as quality control and first-line maintenance. Workers in the distribution unit also got some new functions requiring more knowledge of and interest in informatics. They also have to be able to read and interpret computer data and act accordingly. The company provided better qualified workers through two types of strategy. First, through training the existing workforce, mainly by in-company courses and training courses run by the deliverers of the new machinery. The company had an explicit policy not to fire workers which is why relatively much effort was directed towards the retraining of older workers for new jobs. Secondly, in the longer run when vacancies arise, it attracts new, higher qualified workers from the external labour market. Gradually,

lower qualified workers will become replaced by workers with higher formal vocational qualifications.

In the third part of the chain, the horeca sector, there is less impact of innovations on qualifications. In the horeca sector, particularly managers of businesses who run specific beer marks might be affected by a strengthening of the alliances with breweries. Breweries are in need of good management in the sales outlets for their beers and they have introduced specific tests for managers of their sales outlets. Managers were tested both on the running of the business properly and on selling the make effectively. In some instances, for example in the case of café-snack-tea room managers, management did not have the required capabilities and often could not pass the test. In these cases, breweries stimulated specific training programmes for businesses to raise management qualifications.

4.2 Impact of innovations in cheese production in Greece

According to the Greek report, rapid changes in research and technology have led to the introduction of new technology in the whole agribusiness complex and this has led to a great need for additional knowledge, development of new capabilities and continuous training, both for entrepreneurs and workers. New government legislation with regard to the production, organization and quality standards in the sector have also had major implications for occupations and qualifications. The case study in one of the typical cheese producing regions in Greece, Ipiros, underpins these arguments. A distinction is made between the three main segments of the cheese sector: the sheep farmers, the small cheese plants and the large dairy industries. They are in a different position towards innovation.

As the Greek report states: *'The sheep farmers are very conservative regarding changes'*. Although government development programmes have had a major impact on farms (decline of nomadic breeding, better vaccination and disease control, introduction of new hygienic rules, new varieties of animal food, new milking and milk control techniques), no specific new type of 'job' has been created. New qualifications required are added to the traditional farmers profile. During the change process, several government-supported training programmes have helped sheep farmers adapt to new realities and provide them with adequate qualifications.

A number of small cheese plants are rather resistant towards innovation. Typical small cheese plants are usually family owned. Most owners of the plants, the fathers, are both manager and cheesemaker. They have had no formal education, but have learned the trade in actual practice. Traditionally, cheesemaking skills are acquired on the job and experience is often transferred from father to son. In many cases, however, a member of the younger generation (son or daughter) is also involved in the plant and who usually has received a formal education at agricultural school. In addition, 5 to10 workers are deployed who are usually uneducated in the sense that they have no formal qualifications. The younger, better educated family members are receptive to new regulations and are usually open to

innovations. They collaborate with commercial firms and ask for help from agriculturalists and government consultants. They pass new knowledge on to the other workers in their companies. However, many of the older plant owners are less open to new developments. They try to maintain the traditional character of cheesemaking. This is why the impact of innovations in these companies sometimes has been limited. On the whole, the qualification profiles in small plants have been raised due to the introduction of new methods and techniques, but no specific new types of jobs have come into existence.

The situation in the large dairy industries is different. Companies have mechanized and automated their production systems over the course of years and have introduced modern company structures (usually there is qualified staff available) and they are more open to external influences. They have adopted many innovations in milk processing equipment, production machinery and control instruments. Several new types of jobs and qualifications have arisen, in particular qualified jobs for serving the automated production lines, specialized jobs for the maintenance of installations and higher qualified scientific jobs in fields like quality control and product development. In these companies, there is a continuous need to update the skills of employees.

4.3 Impact of innovations in bread production in Spain

In Spain, the impact of frozen dough production as a peculiar innovative aspect of the bread production sector has been studied. Frozen dough production is an industrial production system which is innovative in itself and, through competition, also affects activities within the traditional bakery systems.

The impact of this new production system on wheat farmers is rather limited: '*The introduction of new varieties does not have an impact by itself on the professional competences of farmers although it might affect their tasks, because it implies the use of specific fertilizers and pesticides and their correct use*'. However, in the long run, growth of product variety might have feedback effects on the chain and also on wheat farmers as they will pose increasing quality demands upon milling plants, who in turn will require greater wheat quality and variety and improved selective wheat harvesting on the part of their suppliers, the wheat farmers. In the milling plants, innovations will also primarily have impact in terms of higher demands for quality and introduction of quality control systems. It is not expected that jobs will change fundamentally. In most cases, quality aspects will probably be added to the work packages of the existing work force.

The introduction of industrial baking through frozen doughs production, for example, has had an important impact on the situation of the Spanish bakery sector as a whole. It is an innovation which, through competition, can even have a larger impact on traditional bakeries in the future. A certain division between the segments of industrial and traditional baking has already taken place. The opinions differ, however, about what the further impact of industrial baking on work and qualifications will be exactly. At the one side, a loss of craftsmanship and

professionalism and a kind of deskilling of the baker's work is expected. This will occur initially in industrial bakeries themselves, but traditional bakeries are also threatened by this tendency. At the other side, however, competition with industrial bakeries might stimulate traditional bakeries to diversify their product range, modernize their establishments and develop extra services for their customers. This could lead in these bakeries to an increase of competences required from managers and workers. People would have to know more about different products, acquire better communicative skills and specific sales qualifications and establish more customer-oriented attitudes. However, this tendency of a broadening and upgrading of skills could be obstructed by a growing need for cost efficiency and rationalization of work. Actually, the overall picture in the bakery sector appears to be heterogeneous in this regard.

In bread distribution the most sensitive element is the competence of sales persons, the Spanish report states. Both frozen dough producers and traditional bakeries have to give special attention to the qualifications of their sales staff in order to establish durable relationships with customers. For the larger frozen dough producers, this mainly regards the sales units with their specialized commercial staff. In the smaller traditional bakeries, the whole staff is affected because sales tasks are normally not organized as specialized jobs.

4.4 Impact of innovations in vegetable production in the United Kingdom

From the UK a systematic recent study into the impact of innovation on qualifications is available. According to this survey (among about. 4 000 firms) a majority of British employers indicated *'that skills required for the average employment were increasing and that this was mostly due to changes in processes and technology'*. Besides, changes in work practices and multiskilling were often mentioned as a factor causing increase in skill needs.

These factors also influence qualification needs in vegetable production, the UK report states.

Innovations on the farm resulting from supply chain pressures are putting new demands on the qualification of the workforce. The most significant factor is the higher need for quality assurance, for example through the introduction of the HACCP system. This system, used by the food manufacturing industry, is also being applied to crop production. The system requires new skills in fields like quality control, monitoring and auditing of quality. Tasks in these fields are normally not organized into specialized jobs, but added to the jobs which already exist. Farmers have to be trained to acquire such new skills.

In food companies, both the jobs of operators on the production lines as well as those of maintenance and laboratory staff are affected by new technology and work organization. The operator work has changed from manual work to monitoring automated processes which requires entirely different skills. Operators now have to be able to read and interpret computerized data concerning all kinds of product and process variables. They have to know more about the different steps in the process, the connection between different steps,

possible failures during the process and automated procedures to correct and prevent the occurrence of failures.

There is also an increasing need for flexibility in companies which requires a broader qualification profile from workers on the production lines. Not only qualifications for production work in the traditional sense are required, but also workers have to be able to conduct, for example, routine maintenance and specific cleaning tasks. Often, multiskilled workers are asked for by companies, e.g. workers who have knowledge about both the mechanical and electronical aspects of machinery and who are able to conduct normal routine tasks in production as well as non-routine tasks in the field of process monitoring, quality control, routine maintenance and small repairs.

The work of maintenance in food companies has become more sophisticated with the introduction of new equipment and new quality control systems. The situation regarding laboratory work is differentiated and might vary from company to company. A general tendency, however, is that part of laboratory work is increasingly outsourced by food companies and replaced by specialized research labs. Independent laboratories are particularly used for routine laboratory tests. Another general tendency is that laboratory testing tends to decrease as a result of the introduction of comprehensive quality assurance systems.

4.5 Impact of innovations in meat production in the Netherlands

In the Netherlands, systematic research has been done on the impact of programmes for integrated product chain management and quality improvement in the meat production sector, in particular in pig production. Some of the findings of this research conducted by the agricultural research agency STOAS are relevant. They particularly concern cattle farms and meat processing companies.

Firstly, within companies themselves, participation in product chains especially has consequences for management jobs and jobs in the sales departments. Thus far, participation in product chains means primarily a greater exchange of information about products and production methods between companies.

Secondly, at company level no new types of jobs have been established related to chain management. Activities in this field, like the monitoring of supply quality, communication with suppliers, analysing customers feedback etc., are mainly organized within the framework of quality management.

Third, within the companies, quality management affects the jobs of all the workers from upper management to the shop floor.

Fourth, in a number of large companies, specific jobs in the sphere of quality control and management have come into being; these are often combined jobs, which also include tasks such as environmental care and health and safety at work.

Recently, STOAS also conducted research into the impact of technological and commercial developments – especially the trend of selling more fresh food – on commercial functions in the food retail trade. The main conclusion is that these developments have only a limited impact on the activities of the staff in shops. Especially management and sales jobs are affected. *'On the whole, jobs are changing'*, STOAS concludes, *'because more elements of quality care, communication and information exchange become incorporated, but the changes are not so severe that new types of initial vocational education programmes would be necessary'.*

4.6 Resumé

If we look at the arguments put forward in the national reports, we might conclude that qualifications in agribusiness are clearly affected by innovations, but that the degree of impact is different in the different segments of the product chains. The most severe impact is visible in food processing companies. Here, qualification requirements are generally rising. More product and process knowledge and analytical skills are required, more in-depth knowledge of mechanical and electronical aspects of equipment is asked for by companies. In addition, new skills in fields like quality control and monitoring are added to the profiles of production workers. Sometimes new types of jobs have been introduced in these companies which require higher levels of formal education, such as the jobs of process operator, line supervisor, quality controller and lab researcher. However, many innovations are also incorporated through an extension of existing jobs and qualification profiles with new elements, in fields like quality assurance, maintenance, monitoring and communication.

The impact of innovations on qualifications in the initial stages of the chains – the farms – appears to be less intense. Here also, additional knowledge is required, although it is a kind of knowledge which is in line with the cultivation and processing knowledge already available at many farms. Usually, further training might be built upon this existing knowledge basis. However, in a case of rapid modernization like sheep farming in Greece, such a strategy no longer appears to be sufficient – a more fundamental strategy has to be followed. In Greece, for instance, a combination of regional development programmes, new education and training provisions and specialized agricultural consultancy services was used for farmers to be able to cope with the requirements of new technologies, markets and legislative demands.

At the end of the chain in the food retail trade, innovations appear to have had relatively the least impact on qualifications. New requirements in fields like customer orientedness, information and communication and sales skills are usually incorporated into the existing job profiles. Only in some sectors and some larger companies have special new logistic competences crystallised into a new occupational profile, usually covered by the label of 'supply chain manager'.

5. ROLE OF SECTORAL AGENCIES IN INNOVATION-RELATED TRAINING

After having described the major innovations and their implications for qualifications in the product chain, we will now turn to the subject of training and learning, as being major elements of the transfer of innovations in agribusiness companies. How do different agencies active in this field cope with new qualification requirements and training demands in relation to innovation? What is the role of vocational schools and sectoral training institutes in this regard? How relevant are networks between companies and other network alliances for the acquisition of new qualifications by employers and employees? First, we will draw some general conclusions on these points. Then, we will go on to describe the initiatives in the different countries in more detail and elaborate some examples from the national studies as illustrations to underpin the arguments.

5.1 General conclusion: limited sectoralization in agribusiness regarding training

Before discussing the role of the different agencies involved with training in some way or other, we first want to draw some general conclusions. As the national reports clearly indicate, training policies and activities in agribusiness are sectoralized only to a limited degree. This holds true for each of the three segments (agricultural production, food processing, food retail trade) in each of the five participating countries. There are seldom clearly established educational institutions which represent a specific branch of companies with equal economic activities and which are responsible for the development of a specific training policy for that branch and which coordinate the various training initiatives for farmers, managers and workers of that branch. This is not to say that there are no education and training institutions in agribusiness. There are indeed institutions, but usually these are primarily active at the level of the segments as a whole. This is particularly visible in the segment of agricultural production which traditionally has strongly been regulated by (government) policies and has developed strong representative interest organizations. In food industry and the retail trade, this has occurred to a much lesser degree although educational organizations can be identified in these segments which cover the segments as a whole. These overarching institutions, however, cover and represent a very broad and heterogeneous field of companies. If we compare it with other economic sectors (such as the car repair sector, the installation sector or the printing industry), we might say that in the cases of agricultural production, the food industry and the retail trade it is better to talk about 'conglomerates' or 'clusters' of sectors than to apply the sector concept itself. Within these conglomerates certain subsegments of companies with equal economic activities might be identified for which the concept of sector would be better applicable, for instance 'sectors' like cereal production, meat production, vegetable production, fruit production, sweets production,

fisheries etc. Equal distinctions could be made in the segments of food processing and the food retail trade. In actual practice, the sector concept sometimes is used to make classifications on this level. However, these 'sectors' still cover a large variety of companies. For the purpose of this study, we have used the term 'agribusiness complex' to indicate this heterogeneity at company level.

Heterogeneity qua type of activities might be one reason for the limited degree of sectoralization. This applies in particular to the segment of agriculture itself, with its large variety of products. Another reason might be the heterogeneity within the segments with regard to company size and structure. Both in the food industry and food retail trade, there is a kind of polarization between some large industries and supermarkets on the one side, who dominate many (international) markets, and on the other side, the great majority of small firms and shops who work for the local market or are specialized in small-scale production for specific market niches and who often are in severe competition with larger firms. In Greece and Spain, this difference in the scale of companies goes sometimes hand in hand with differences in the degree of modernization of the companies. The large firms have modern production systems and are connected to (international) trade and information networks. The smaller firms often work in traditional ways in traditional establishments with traditional equipment and cut off from developments on the wider markets.

The low level of sectoralization is particularly striking in Belgium and the Netherlands. Both countries have well developed sectoral training systems based on social partnership in many other branches of the economy. Both in Belgium and the Netherlands there are many institutions involved in education and training in agribusiness, but in neither of these countries training policies and initiatives are coordinated at sectoral level in the sense described above. The 'sectoral' agencies which do exist represent broad clusters of very heterogeneous groups of companies. Although they do have differentiated programmes regarding different branches within their segment, in general, they appear to have too little influence to be able to develop the sectoral level as a separate level for the organization of continuous training.

Partly because of this lack of sectoral coordination, in the first instance the training field in agribusiness looks a very fragmented field. However, we can distinguish different types of agencies which in their way and in their specific domain, contribute to training initiatives on a collective level. The companies themselves come into the picture as important providers of continuing training, in particular in the food processing segment. We will give some examples of in-company training initiatives in the following paragraphs. Furthermore, training initiatives, or better: learning processes, are not always limited to one company. They may also be embedded within company networks or within networks of companies with other agencies involved in innovation. In this regard one can think of the opportunities for training and learning within the context of local networks of entrepreneurs, supplier-manufacturer-retailer relationships or regional networks of consultancy agencies, government authorities and company representatives. In the following paragraphs we will also give examples of training and learning taking place within such networks. Here, we will focus particularly on the inter-company level. In the next sections we will broaden the view to the knowledge infrastructure

as a whole and go on to discuss more explicitly the role of research agencies and research affiliated networks.

5.2 General conclusion: limited cross-sectoral collaboration

A second general conclusion we want to draw refers to the fact that training initiatives in the three segments we have distinguished are only connected in a rather loose way. There is not so much collaboration and coordination between training agencies for agriculture, the food processing industry and the retail trade respectively. The national reports clearly demonstrate that training traditions in these segments have developed along different lines and that training institutes in the first place tend to look for more coordination within their own segment – the lack of it is often perceived as a real problem – then across the segments of production, processing and trade. The Spanish report explicitly argues that a sectoral approach to training runs the risk of failure when applied in agribusiness, precisely because of this lack of coordination between segments in the light of new developments in technology, consumer demands and international competition, which cross through sectoral (and national) borders.

As indicated in the UK and Dutch reports, concepts like 'product chain' and 'supply chain management' have been introduced to overcome some of the disadvantages of a too strict segmentation between agricultural production, processing and distribution. Thinking in terms of supply chains has originated in marketing and has strongly been pushed forward by large retailers and manufacturers from a commercial and quality point of view, but it also might open new options for the organization of knowledge transfer and training, especially with regard to innovation processes. We can for instance refer to an example given in the Belgian report about quality information feedback and information exchange about new cultivation procedures between breweries and their suppliers of hops and grains. Another example is included in the UK report which refers to mutual exchange of personnel of crop growers and crop processing companies with the aim of getting better informed about each other's production processes and conditions. We have described this example in the previous section. These are clear examples of learning processes which might take place in chain relationships that cross the borders between farming, processing and retailing. As the examples illustrate, a product chain approach could help to overcome some of the limitations of a purely sectoral approach to training. However, at the same time, as the Dutch report states, thinking in terms of product chains can also lead to practices with too little flexibility. Product chains might be defined in a too narrow way and relationships might be organized on a too narrow basis so that there is a risk of overspecialization in the field of training. For commercial reasons, the contents of training and learning 'progammes' might be too strongly related to very specific demands of the dominant agencies/companies in the product chains and this might lead to a too narrow profile of the qualifications acquired through these programmes. Such an overspecialization might be in the interest of the companies involved, but it might impede the development of a broader qualification basis of the involved workers and entrepreneurs.

In this sense, the concept of training or learning 'network' can fulfil an important additional role. In recent Dutch discussions about future scenarios for education and training in agribusiness the network concept is given a higher priority than the supply chain concept, precisely because supply chains are held to be no longer flexible enough to respond to continuously changing technologies and market demands. Skill needs in agribusiness tend to become more general. There is a growing demand for skills like quality control, hygienic, commercial and sales, process control as well as skills in the field of information technology, etc. and training programmes should meet this more general demand. Training within the context of supply chains could in principle cope with some of these more general needs because these are aspects which are also very prominent in supply chain management, as the UK report argues. However, the UK report also stresses another risk connected with supply chain relationships, e.g. the severe commercial pressure which dominant agencies in the chains (large supermarkets, large food companies) might put upon their 'partners'. In the UK, in some cases such as the cattle branch, this has had such damaging effects on the social relationships between the partners that there is no real basis for organizing activities like training in a collaborative way on chain level (cf. King & Kruse, 1996). This would be another reason to look for opportunities for organizing training and learning activities on a (chain-crossing) network basis. We will elaborate this aspect further in the next sections and the following chapters.

5.3 Differences in the nature and pace of the innovation processes

A point we also want to stress here is the differences regarding the nature and pace of innovation processes in the different subsegments of agribusiness. This is an extra complication in the relationship between innovation and qualification which is emphasized in several of the national studies. In discussing this point, we have to keep in mind that, on the whole, the level of R&D investment in agribusiness is rather low if compared to R&D investment in other sectors. However, R&D investment ratios are not always good indicators of the impact of innovations on farm and company level. This impact might be very different.

The Greek study points to the differences between innovation in the small milk plants and the large dairy industries. The former are rather reluctant to innovation, try to uphold traditional ways of working and are not very open for influences from their environment. Innovation goes on at a slow pace and concerns only slight changes in processes or production methods and equipment. The large dairy industries on the other hand operate on an international scale. They are connected to international trade and R&D networks, use already a lot of modern technology and deploy a staff which is adequately qualified to deal with new developments in products and production processes. Innovations are introduced here at a more rapid pace and on a larger scale than in the small plants.

The Spanish study also stresses these differences in the nature and pace of innovation. Farming, food processing and retail trade are characterized by very different innovation cycles. The innovation processes are structured in a different way, different agencies play a role in the innovation processes and the impact of innovations is very different in the three subsegments. For instance, in farming innovation occurs more in cyclical processes. Here, continuous experiments of farmers and feedback from their customers, e.g. the food companies, gradually leads to improvement of cultivation techniques. In the food industry, on the contrary, innovation originates on the international research market or within the research labs of the large companies. Here, innovation occurs in a more linear transfer process from the research system towards the production system.

Innovation cycles might not only differ from segment to segment but also within a segment innovation may proceed in very different ways depending on the product and the structure of a certain product chain. This variety and complexity of innovation is one of the reasons why in actual Dutch discussions about the restructuring of the agricultural knowledge infrastructure, the concept of 'innovation networks' is strongly promoted. Such networks are alliances in which very different actors from very different circles (research, engineering, training, production, public authorities) can participate. These alliances have a temporary character and are formed around a specific problem which represents a common interest for the participants. Such alliances can be organized quickly and can also be dissolved easily if no longer necessary.

We will elaborate this aspect of the complexity of the knowledge infrastructure and the role of networks in innovation and training further in the next chapters. Now, we will first go on with a discussion of the role of different agencies in continuing training. We will focus in particular on the role of vocational schools, sectoral training institutes and bodies, companies and company networks and networks of entrepreneurs.

5.4 Role of vocational schools

As indicated before, in many instances, agencies at the sectoral level play a limited role in agribusiness as it comes to the provision and coordination of continuous training. Actors at other levels then come in to fill this gap. Several national reports point to the role of vocational schools in the provision of continuing training. In particular in agricultural production this appears to be the case. Vocational schools appear to have a less prominent role in the food industry and in the food retail trade in most of the countries involved. Vocational schools are, of course, primarily involved in initial education and training for newcomers to the sector. However, they might also develop specific courses and programmes for adults which already have a job in the business.

An interesting example can be found in the Greek region of Ipiros, where one of the practical agricultural schools is also used by the prefecture as a Centre of Vocational Agricultural Training (CVAT). These CVATs are schools for both initial and continuing vocational

education. One of their tasks is to provide extra-curricular vocational training to the farmers and breeders in the region. There are nine CVATs in the district of Ipiros. With the aid of the government these CVATs exploit a training centre, have some teachers and teaching classes and use up-to-date teaching material. They have an extensive area for practical training and have close relationships with agricultural scientists of the agricultural development department. They offer courses on subjects like EU legislation, government policy regarding sheep breeding, genetic improvement of sheep and goats, animal feeding, animal diseases, milk processing and marketing. Mostly, seminars are used for further training. The seminars are financially supported by the government and are usually free of charge. Many farmers in the region have participated in the seminars and have got certificates.

Another example can be found in the Netherlands. Here, the agricultural vocational schools are in a process of restructuration with regard to their educational programmes, internal organization, external relationships and target group strategies. Thus far, the schools have primarily focused on providing basic education and training for pupils who want to become a farmer or to get a job in agriculture. Increasingly, however, they tend to add to this the tasks of providing training and retraining programmes for persons/adults who are already deployed in agriculture, e.g. both farmers and workers. In recent discussions an even broader task is envisaged for the agricultural schools. They should also play a role in the stimulation of innovation among the businesses in their regional environment. In order to fulfil this role they should both adapt the structure of their training programmes (make them more flexible) and their relationships with the business community. Actually, for most of the schools this would be a step too far it is argued in the Dutch report, but it is a serious option and many schoolleaders are thinking about how to position their institute more strategically within the regional environment.

5.5 Role of sectoral training institutes and bodies

Sectoral training institutes and bodies play a less prominent role in agribusiness than in many other sectors we have seen, especially in countries like Belgium and the Netherlands. For a part, this is due to the heterogeneity of agribusiness as we have argued above. For a part, it has also something to do with the low level of collective organization in agribusiness as compared to other sectors. For the employers, collective organizations have been developed in certain branches and sometimes they have an important role as an interest group in their branch but most of the organizations are rather small and cooperation between them is often rather limited. For the employees, collective organization is rather weak if compared with other sectors. Many employees in agriculture are not organized in trade unions. With the exception of Spain, there are no specific trade unions for agricultural workers. In the food industry union, trade unions do exist and membership levels are usually higher, but also here many of the lesser skilled and temporary workers are not organized. The same holds true for the food retail trade. As a consequence, social partnership in agribusiness generally provides a fragmented picture. Collective labour agreements have been developed to a much lesser

degree than in (other) industrial sectors. Joint bodies and joint institutions of employers associations and trade unions are rather scarce. In the food industry, social-partnership based institutions sometimes do play a more prominent role. But in agricultural production and in the retail trade such institutions have only been developed to a limited degree.

However, there are initiatives going on in this field. The Spanish report describes an interesting example of a sectoral training institute in the cereals production and milling branch, established as an initiative of the trade union. The institute organizes further training for professional workers who provide technical assistance in processes related to cereal subproducts, e.g. laboratory workers and technicians. The institute particularly strives to train (future) professionals to be able to deal with technological advances introduced in the production systems. Some of its training activities have close links with other activities it deploys in relation to R&D and innovation transfer, such as provision of technical assistance to industries, applied research studies and projects in companies, design of specific in-company tailored training, promotion of technical congresses and meetings and publication of a technical journal. Applied research projects are carried out with involvement of the trainees themselves, so, as the Spanish report states, this already ensures in a certain way the transfer of know-how to the firms where the trainees later will find a job. Many workers in cereal production have received training from this institute since its establishment in 1982.

Besides this specific union-based institute, training on a sectoral level in Spain is also provided by the national agency for the development and funding of occupational training (FORCEM). This agency mainly provides general technical courses for industrial sectors, among which is the milling branch.

Another example can be find in the UK where the National Training Organization (NTO) has recently been introduced. These NTOs are new independent employer-led sector organizations recognised by the Department for Education and Employment. The NTOs closely collaborate with the government and the business communities and have tasks in the fields of both basic education (e.g. to improve relationships between schools and companies) as well as lifelong learning (e.g. promotion of individual learning accounts and careers in the sector) and the establishment of occupational standards and sectoral training targets. NTOs are especially active in the food and drinks sector. In earlier times, there were 11 such training organizations but they have merged into broader groupings so that now four NTOs represent the food and drinks sector (food and drinks, meat training, seafish training, dairy industry).

A third example can be found in the Netherlands. Here, the training institute for agriculture and food technology LOBAS is active in providing training for managers and workers in agribusiness. LOBAS is the national body for the apprenticeship system and has been established some years ago through a merger of the former apprenticeship training centres of agriculture and the food processing industry respectively. The programmes of LOBAS are geared to the requirements of the national vocational qualification standards for agribusiness which have been defined by the social partners. LOBAS primarily addresses young apprentices, but it has a separate department for continuing training offering courses on a

commercial basis to managers and workers in the sector. LOBAS covers the agribusiness complex as a whole although training programmes are divided into subdivisions of the segments, such as wheat farming, cattle farming, glass house farming, food technology, process operator, etc. LOBAS has incorporated several innovation-related qualifications (quality control, product safety, animal health care) in its training programmes in recent years.

Besides this apprenticeship training institute, there are also several training funds in the Netherlands, such as for agriculture, the meat and meat products industry and the dairy industry. Besides these training funds there are also some other smaller 'social funds' in other agribusiness branches. These collective funds are usually financed by a wage levy on companies and administered by joint bodies of the social partners. They support both apprenticeship training as well as training courses for employees. Sometimes, they also support special training and placement projects for the unemployed. Most funds in agribusiness are rather small if compared to collective funds in other sectors, like the building industry or the metal working sector. As experts state, participation in these funds is rather limited, as is participation in training in general in agribusiness.

The Spanish example is union-driven, the British case is employer-led, the Dutch initiatives are based on joint agreements between the social partners. This diversity clearly reflects the different traditions of industrial relations in the three countries. Social partnership with regard to training is hardly developed in Spain and in the UK. In the Netherlands, where collective bargaining and joint funding of training schemes have a prolonged tradition in many other branches of the industry and the services sector, joint collective initiatives in agribusiness have been developed, but they appear to meet serious problems in implementing their programmes at company and worker levels.

5.6 Role of companies and company networks

Instead of collective forms, private forms appear to be most prominent in the organization of training and learning in agribusiness, the national studies demonstrate. This seems to be the case in all the investigated product chains in all of the five countries involved. The private initiatives have many concrete forms, such as in-company courses, on-the-job training, instruction courses of machine suppliers, workplace learning, meetings and study circles of entrepreneurs, learning through networks with other companies, learning through networks with consultancy and innovation agencies. Sometimes public agencies join the private initiatives and contribute to the training with public means.

Two interesting illustrations of the important role of companies as training providers in the food industry are the cases of a large brewery company in Belgium and a large dairy industry in the Greek district of Ipiros. Both companies have established well developed training programmes for their employees. They both also organise several training initiatives within the network of their supply chains. Furthermore, they both conduct many activities in the field

of product development and they have established relationships with private and public research agencies outside their firm.

The Dodoni factory in Ioannina is a large Greek cheese manufacturer already established in the district for more than 30 years. It deploys a staff of more than 400 (including seasonal workers) and has a permanent scientific staff. It has about 12 000 breeders providing milk to the company, 95% for sheep milk. For a number of years, the company has organized special in-company training programmes for its staff in collaboration with the training agency of the local prefecture. The programmes last for about 10 weeks and are addressed to different target groups: marketing staff, dairy technicians, mechanic technicians and electronical technicians. The objective of these programmes is to train the staff to provide them with adequate knowledge and qualifications to be capable of dealing with the introduction of new technologies in the industry. The company has established close relationships with the leading dairy research institutes in the region.

The company also plays an important role in the training of dairy farmers in the region and has a team of agricultural scientists who provide several services to the breeders. They provide technical information through their personal contacts with the breeders and by organizing informal meeting in villages. They organize seminars and training courses for the staff of breeders in cooperation with the local agricultural school. Furthermore, they distribute information among the breeders and stimulate breeders to participate in local development programmes.

The case of the Belgian brewery illustrates not only the role of the company itself but also the important role of suppliers of machinery in the training of technicians in the food industry. This type of training is often not formalized in training courses; it is embedded in the installation process of the new machinery and the instruction and experimentation periods which follow installation.

For instance, during the installation of its new automated beer production department, the deliverer of the machinery was consulted to give advice on the best type of machinery to be used, the possibilities of the machinery, the way to compose different elements of the machinery, etc. In addition, the supplier developed a training programme for the employees who would work with the machines, for the technicians who would have to maintain and repair the machines and for the operators who would have to control the production process. As the Belgian report states: '*In this way, the suppliers of the machinery are becoming more than just suppliers. They also have an important role in guiding the innovation process by introducing better and new techniques and in adapting the qualifications of the employees*'. We think this type of learning which is very common in many industries is often underestimated in discussions about education and training.

5.7 Role of networks of entrepreneurs

The Belgian brewery company, like the Greek dairy produce company, not only organizes training and learning for its own staff, but also stimulates learning among the farmers in its suppliers network. We have already mentioned the practice in this company of giving hop farmers regular feedback on the quality of their supply and of informing and advising farmers and supporting them in their experiments with new ways of cultivation. The Belgian report further points to the fact that what the brewery does in this case is only an extra stimulus for the farmers. The farmers themselves have a long tradition of mutual information exchange and consultancy about products, production problems, new ways of cultivation, new harvesting equipment, etc. This occurs in an informal way, at local level, in specific 'study circles' of farmers who are in the same product branch. Besides the Belgian report, the Dutch report stresses the relevance of such informal circles of entrepreneurs for the development of their qualifications. In the Netherlands also, in many agricultural branches, such circles exist and function as an informal network for the exchange of information and, to a certain degree, the transfer of innovations. Regularly, consultants from research institutes or specialized innovation transfer agencies are invited to meetings of these study groups to give their expert advice.

The Belgian study signals the fact that in many branches, such as in hops farming, there is no special training for farmers. In explaining this phenomenon it refers to some typical circumstances in the agricultural sector: '*First of all the lack of specific training might be explained by the fact that basic or informal training for farmers is provided already. Indeed, most of the knowledge concerning the occupation of farmers is handed over from father to son or daughter. So concerning special production techniques specific training might have little success...Another fact (..) is that many farmers are working according to trial and error procedures. This means that the farmers try new methods or techniques or fertilizers every year on a small part of their products in order to improve the results. If those techniques seem to be successful, the knowledge is often spread into a broad internal network of other farmers that will try those techniques*'. The report further stresses the supportive function of specialist journals and periodical information sessions for farmers in this respect. These are usually organized by the Boerenbond, a professional association of farmers, which supports them with information and consultancy services and represents them vis-à-vis the government and local authorities.

In recent Dutch discussions these circles of entrepreneurs are seen as one of the building blocks of the new innovative networks which have to be created in Dutch agribusiness in order to cope with new economical and ecological pressures. Dutch experts foresee future scenarios in which such circles of the business community itself become connected with other agencies responsible for research, development, consultancy and training. A scenario for the implementation for animal health care strategies (one of the focal points in the future development of meat production, according to experts) could for instance consist of the establishment of a network of researchers, consultants and practitioners/farmers, which

would collaborate in the execution of a number of pilot projects aimed at developing, testing and adapting new breeding and processing systems with a greater degree of 'animal friendliness'. Vocational schools and other training centres could also participate in such projects.

5.8 Resumé

In conclusion, we might say that agribusiness is 'sectoralized' to a lesser degree than many other segments of the economy, not only in the field of education and training but also with regard to industrial relations, collective bargaining, trade union organization, social partnership and employment and labour market policy. Partly, this is due to the great heterogeneity of the different segments of agribusiness (agricultural production, food processing industry, food retail trade). Partly, it has to do with the tradition – in many countries – of strong government regulation and protection in this field. One might say that under the umbrella of government regulation there was less need for self-regulating mechanisms to be developed by the business community itself. Collective organization is weak, particularly on the workers side. Social partnership is less developed. Joint arrangements and institutions have found a less fruitful soil than in other segments of the economy. However, in some instances, as we have seen, sectoral initiatives in the field of training have taken off during the past decades. In Spain these are union-led, in the UK they are employer-led, in the Netherlands they are organized on a joint basis. If we overlook all the evidence in the national reports, however, we must conclude that examples of joint initiatives of the social partners are rather scarce in agribusiness.

As collective, sectoral initiatives in training have been less developed, private initiatives come into the picture, the national reports clearly demonstrate. We have discussed the most important ones and have given concrete examples in the national studies. Private companies themselves are often major providers of continuing training for workers, in particular the large food companies. In addition, networks of companies and networks of entrepreneurs might play an important role. Especially in the food industry, supplier-manufacturer networks offer opportunities for organizing training and learning processes. In agricultural production, formal and informal networks of farmers and breeders provide opportunities for information exchange, mutual consultancy and more formalized training sessions.

We have also concluded that thinking in terms of 'agrochains', which is actually strongly promoted for economical and commercial reasons (see the UK and Dutch reports) can provide opportunities to overcome some of the disadvantages connected with the actual institutional segmentation in agribusiness. Product chains cross through existing institutional domains and might provide companies from different segments with a common interest on which to build training activities. However, too rigid organization in terms of product chains might also impede adequate training because it runs the risk of qualifying people for a too narrow strand of work. In order to prevent such 'overspecialization', several experts propose

to take the broader notion of 'networks' as the basis for the organization of training activities. We will turn to this point in the next chapters.

6. TRANSFER OF INNOVATIONS AND THE KNOWLEDGE INFRASTRUCTURE

Training, as it has been discussed in the previous chapters, is only one of the instruments through which innovations are transferred in a certain organizational field. As a whole, the transfer of innovations is a complex process in which a multitude of agencies might play a role, depending among others on the nature and scope of the innovation and on the structure and context of the economical domain to which it has to be transferred. In this chapter, we will try to highlight this complexity by looking at the knowledge infrastructure in agribusiness. We will describe its major segments, their interrelations and a number of actual developments taking place in the countries involved. The focus will be broader than in the previous chapters, because developments in the knowledge infrastructure exceed the level of concrete product chains. At the end of this chapter, we will specifically look at the position of education and training in the knowledge infrastructure. We will refer to the influence of market forces and to the consequences of a growing market influence for the relationships between the major agencies involved in innovation and training in agribusiness. In the next chapter we will then go on to discuss this point further by elaborating the concepts of 'innovation networks' and 'learning networks'.

6.1 The knowledge infrastructure in agribusiness

First, we will address the question of what is meant with the concept of a 'knowledge infrastructure'. With this concept we refer to all activities and agencies involved in one way or another with the generation and dissemination of knowledge in a certain institutional domain. The concept of a knowledge infrastructure originated – at least in the Netherlands – in economic science, as a complementary notion to economical notions such as physical infrastructure, transport infrastructure, production structure, etc. Recently, it has been taken up in organizational and educational sciences as one of the concepts with which issues in the field of vocational education and training can be linked to the labour market, employment, (regional) development and innovation policies.

Now, what does the knowledge infrastructure in agribusiness look like? Concretely, this infrastructure is different from country to country, as national resources, traditions and institutions are variant, and from segment to segment, as type of products, production systems, technologies, company structures and relationships between companies are different. With the help of the arguments in the national reports, we can get a picture of the basic elements of the knowledge infrastructure in the different countries and of some basic ways in which these might be interrelated.

6.2 The Dutch case

In the Dutch agribusiness sector, the terms 'knowledge infrastructure' or 'knowledge system' are normally used to depict a configuration of agencies working in three major fields (Grooters, 1994):

- research and development;
- consultancy and advice;
- education and training.

Traditionally, in the Netherlands, each of these fields is subjected to strong government regulation. There are special directorates for each field in the Ministry of Agriculture. Activities in each field are usually programmed and planned by extensive policy procedures. Agencies are autonomous in the execution of programmes, but have only limited autonomy in strategic decision making. Traditionally, programmes and activities are directed under the authority of the different departments of the Ministry of Agriculture. Major research agencies, like the University of Wageningen and the Dienst Landbouwkundig Onderzoek, are largely financed with public resources. The same holds true for a major consultancy agency in agribusiness, the Dienst Landbouwvoorlichting (National Agricultural Consultancy Service). Typical for the situation is that (initial) vocational education in agriculture is separately organized under the authority of the Ministry of Agriculture and not of the Ministry of Education, which regulates vocational education in other parts of the economy. Traditionally, decision making in the different parts of knowledge infrastructure – from research and development to education and training – is rather centralized, with an important role for the government agricultural departments and the central agricultural organizations. The execution of consultancy services and educational programmes takes place in regional consultancy offices and a number of agricultural vocational schools which are spread out over the country. All in all, we might say that the Dutch knowledge infrastructure is traditionally based on a science-driven innovation model, which supposes direct lines from knowledge generation in research and development to knowledge application and dissemination in consultancy and education.

As the national reports indicate, this situation is not only characteristic for the Netherlands. In Greece and Spain also, the government traditionally has had a strong foothold in the agribusiness knowledge infrastructure. This appears to be less the case in the UK and in Belgium, at least in the segments we have investigated in this study (salad production in the UK and beer production in Belgium). Here, market forces already strongly influence research, consultancy and training for a longer period of time and market influences are clearly intermingled with government impulses. Private agencies are important players in the field, besides government-related institutions. In the next sections, however, we will show that in Greece, Spain and the Netherlands too the knowledge infrastructure increasingly tends to become subjected to market pressures.

6.3 The Greek case

The Greek report stresses the important role of governmental institutions and interventions through the application of (EEC) legislation, economic development programmes, support of research institutes and university research labs and consultancy services at district level. An important research institute in the dairy industry is for example the Dairy Institute of Ioannina, which belongs to the National Foundation of Agricultural Research, a research institute of the Ministry of Agriculture. The institute conducts research in fields like milk analysis, quality improvement, standardization of cheese products, development of new milk-based products and protection of consumers. The institute also provides information and training services, mainly through publication of research results in brochures and information leaflets. Other major research institutes, supported by the government are the departments of food science and technology and of agricultural economics of the University of Thessaloniki, which carry out specific research programmes in fields like bacteriology, biotechnology and economic development with regard to the Greek milk and cheese production sector. As the Greek report states, many government led innovation programmes in the dairy industry are conducted in collaboration with the (larger) private companies. Research projects are often sponsored with EU resources.

The government also plays an important role in the provision of consultancy and education facilities. On the level of Districts (seven in total) and on the level of the Prefectures (56), separate services play an intermediate role between the central organizations and the local farmers and businesses. In the Prefecture of Ioannina, for example, the Direction of Agriculture – which falls under the authority of the District Service of the Ministry of Agriculture – organizes both consultancy and training services. It has a Department of Agricultural Extension and Development, which deploys a number of agricultural scientists who provide farmers and breeders with personal advice regarding animal husbandry and production. And it has a Centre of Vocational Agricultural Training (CVAT), which provides extra-curricular vocational training to the farmers and breeders. We have mentioned the role of this CVAT already in the previous chapter. Consultancy is further provided by the Direction of Veterinary Services, which deploys regional teams of veterinarians responsible for the control of breeding exploitation in the prefecture and for informing and advising the breeders on subjects regarding animal husbandry. The Greek government is further responsible for curricular vocational training via the Technical Vocational Schools. In Ioannina, for instance, there is one such school which grew out of a practical agricultural school and is specialized in dairy-farming. This is a well-developed school, with good facilities and a substantial number of students. In general, however, this type of vocational education has only been developed to a limited scale in Greece.

As the Greek report demonstrates, science, research and development programmes in the milk and cheese sector have strongly been influenced by the introduction of EU directives and new governmental regulations regarding product standards, quality and safety and production hygiene and control. In this sense, innovation is not only 'science-driven' but also 'legally-driven'. The innovation process generally follows a linear model with new knowledge

being produced in the (fundamental) research institutes and being disseminated to the farmers and businesses through specialized agencies for consultancy and training services. Private agencies, like the large dairy companies with their agriculturalist staff, play an important role in the provision of innovation-related continuing training.

6.4 The Spanish case

The Spanish report also refers to the important role of the public R&D structure in agribusiness in Spain. The National Institute of Agricultural Research and Technology is responsible for planning and programming sectoral research priorities, funding of specific action programmes and R&D projects. The institute has a subdirectorate which authorizes four research centres: a centre for research and technology in general fields like molecular biology, virology, genetic animal and plant improvement, animal reproduction and foodstuffs technology; a research centre in animal health; a forestry research centre and a centre of phytogenic resources. Actions funded and developed by these centres, fall into five groups: technological R&D projects; demonstration projects for integrated application; maintenance and improvement of the R&D infrastructure; implementation of special actions for fostering international cooperation in R&D; and implementation of training activities for research staff. Thus, the institute not only has a role in the generation of new knowledge but also in its application and its dissemination (demonstration projects!) towards the business community.

The Spanish report also refers to the role of regional public agencies in (applied) R&D, technology transfer and consultancy. A part of the public R&D system in Spain is organized at the level of the autonomous communities. As an example, the Institute for Agrifood Research and Technology in Catalunia is described. It is a public enterprise created by the government of Catalunia to promote technological innovations and applications as a means to the modernization and economic development of the agribusiness sector in the region. The institute maintains research centres and laboratories in fields like vegetable production, animal production and food technology, and it supports research projects commissioned by regional and national authorities and by the private sector. *'Its function is not restricted to research*, the report states, *but also includes technology transfer, which means that the research carried out is inspired by its applicability'*. Mechanisms for transfer include specialized publication media, information leaflets, sales contracts on the use of patents, technical assistance and expert advice to businesses and the provision of specialized training courses and seminars. The institute has established collaborative relationships with both the scientific community (universities) and the business community in the region.

The government also plays an important role in vocational education and training. In Spain, education and training are regulated at national level through three national planning systems for initial, occupational and continuing training respectively. With regard to the subsystem of continuing training, on the basis of the National Agreement for Training of 1993, a national Foundation for Continuing Training in Companies (FORCEM) was established which is jointly managed by the social partners. The fund allocates national and EU resources for continuing

training on the basis of a sectoral approach and with the help of a number of joint sectoral committees. Separate committees have been established, e.g. for the agricultural, silviculture and fishing sector and for the food and beverage sector. These sectoral committees decide on the funding of company training plans, plans of clusters of companies, plans of the employers' associations and plans of the (larger) trade unions in the sector. There are plans to federalize this system and establish new regional committees specifically for the autonomous region of Catalunia.

So, in Spain like in Greece and the Netherlands, we clearly recognize the different subsegments of the knowledge infrastructure – research, consultancy, education – and the important role public agencies play in these fields. However, these subsegments appear to be only loosely connected. There are some links between research and consultancy, as we have seen in the case of Catalunia, but the relations between the research system on the one hand, and the formal education and training system on the other are only weakly developed. In general, continuing training as offered by FORCEM is not focused on innovation processes in the different segments of agribusiness, the Spanish report states.

6.5 The case of the United Kingdom

In the UK, the situation appears to be more diverse. Here, besides government supported research institutes, also private initiatives occupy a strong position in research and development. Furthermore, both fundamental and applied research have increasingly become subjected to market forces. R&D institutes increasingly work on the basis of private funding. Mixed public-private initiatives can be found in technology transfer and consultancy too, and in education and training.

R&D is carried out in three types of institutions: university departments for food science and technology (one of the largest is the University of Reading); the government funded Institute of Food Research; and a number of membership-based research associations. All the university food departments undertake research, sponsored by the government, the industry or the EU. As the UK report states: *'Industrial research is encouraged by a number of schemes that offer matching funding when companies support a university research programme'*. The universities are also active in the field of technology transfer and vocational training for professionals. For this, partnerships with private consultancy and training agencies and private companies have been established, sponsored by specific schemes to stimulate collaboration between academics and the business community. The Institute of Food Research is a multi-disciplinary research institute working for a broad customer base including government departments, EU, research councils, the industry and consumer groups. The emphasis is on food science rather than food technology: *'Its stated aims are to stimulate industrial innovation, improve the safety of the food supply, help consumers choose a healthy diet and contribute to the quality of food and ingredients. It works across a broad spectrum of food commodities with particular stress on nutrition, food safety, food acceptability and food biotechnology'*. The food and drink research associations are

membership-based organizations and provide a wide range of technical and advisory services. They carry out contract research both for public and private customers, exploit laboratories for chemical and microbiological testing and specialist analytical services and provide training and information services, consultancy and services like marketing research, auditing, product and process development. Thus, these organizations play an important role in the transfer of innovations from the research system to the production systems in companies.

The UK government is also active in technology. To stimulate technology transfer it has recently introduced some interesting new instruments. One of them is the LINK research scheme, in which the government collaborates in the funding of industrially relevant research. The scheme is concerned with pre-competitive research and promotes partnerships between the industry and research institutes in this field. Primarily, basic research with participation of larger companies is supported. Several important agrofood areas, like agrofood quality, sustainable farming systems, hygienic food manufacturing and sustainable livestock systems, are covered by the LINK programme. We will describe it in more detail in the next section as an example of a scheme which stimulates the development of new network-like forms of organizing innovation in agribusiness. A second new instrument is the Teaching Company Scheme which is designed to help companies of all sizes to make strategic advances through close market research and process development. With this scheme, projects build up around talented young graduates who actually work in a company and can be supported with public grants. Through such projects, academic knowledge is made available to benefit the industry. A third new instrument is the regional technology transfer centres recently established by the Ministry of Agriculture. These centres are particularly directed towards SMEs. As the UK report states, the major objectives of the centres are *'to stimulate increased awareness and uptake of modern food technology by SMEs by strengthening the links between food manufacturers and local academic centres of expertise...The Ministry would like to encourage centres that would act as gateways for technology input to the local community and as training providers'*. With support of the government, the centres can organize collaborative partnerships between expertise centres and the local business community. We will discuss their role also in more detail in the next sections.

Education and training in the UK's agribusiness also encompass important private elements as we have seen earlier. Apart from the private training activities of the research associations and institutes mentioned above, we refer to the national training organizations for the food and drinks industry described in the previous chapter. These are employer-led organizations recognized by the government who work strategically with their sector and with the government and whose aim it is *'to help the government extend and improve its dialogue with employers to assure that the needs of business are taken into account in developing policy'*. Among others, they deploy activities in the field of labour market research, assessment of education and training implications of technological change, training needs analysis, training target-setting, promotion of lifelong learning, stimulation of career development and implementation of vocational qualification standards. According to the UK report, NTO funds

come from a variety of sources but their primary source of support are the employers in the sector. Besides, they can benefit from government departments, EU programmes and their own commercial activities.

So, in the UK, besides government regulations, market forces play an important role in major segments of the knowledge infrastructure, e.g. research, technology transfer and staff training. Both the market for R&D as well as the training market have become increasingly liberalized during the 1980s and 1990s. The government now rather acts at a distance setting only general regulatory frameworks for R&D, supporting combined public-private research programmes, facilitating technology transfer by supporting specialized intermediate consultancy agencies, sponsoring collaborative partnerships between expertise centres and the industry, stimulating market-oriented training through joint efforts with the sectoral training organizations and providing only general output standards for vocational education through the NVCQ system. The government seldom intervenes directly in research, technology transfer and training. Developments in the agribusiness knowledge infrastructure are strongly market-driven, the UK report stresses again and again.

6.6 The Belgian case

In Belgium, market forces and private agencies also play an important role, at least in the product chain we have studied: beer production. A few large industrial breweries together with a number of smaller niche-players dominate the picture here. Research focuses not only on improvement of basic ingredients and beer products but also on process technology and production machinery applied in the large breweries. Product development and production process innovation often go hand in hand, as differentiation of consumer demands, globalization of markets and an intensified international competition stimulate production of new beer varieties on an increasingly larger scale in increasingly higher automated factories.

The Belgian report divides the research centres that are active in the brewery sector into three groups: the university related research centres, the brewery related research centres and the machinery production related research centres. Three types of research activities are conducted in these centres: research for improvement of production techniques, research for application of new ingredients and research for new products. Research in the machinery production centres is mainly focused on improvement of techniques. University related centres cover a broader field. Apart from the search for improved techniques, they also try to find new applications for ingredients. The brewery related centres are depicted in the Belgian report as the most important ones. They are exercising their research in the three domains. They are looking for better techniques, for applications of new ingredients and for the development of new products. They have special research programmes of their own but they also have an influence on the research which is done at university centres and at machinery production centres because these centres, for a part, adjust their research to the demand of the breweries. According to the Belgian report, the breweries are the central actors concerning innovation in the different parts of the product chain. Actually, it is the breweries

that stimulate the real innovations in the first part of the production chain, e.g. hop farming, by transposing their demands concerning basic ingredients to the farmers and defining the criteria these ingredients should meet. Furthermore, the breweries have the lead in innovations in the brewing process itself which takes place in their own factories. The Belgian report describes the case of Interbrew, the largest beer producer of the country. This company has its own R&D staff which continuously tries to improve the quality of products, tries to find new ways of brewing and tries to develop new product lines. The research staff collaborates occasionally with university or high school based research centres, e.g. in carrying out practice experiments and for placement of apprentices. The case of Interbrew also demonstrates a third important role of the breweries, e.g. their role regarding the adaptation of new technologies and production techniques developed by machine manufacturers in concrete operating systems. The need for innovation, e.g. automation in the large breweries, causes a demand for new machinery which, in turn, stimulates all kinds of innovations in the machinery supplying industries. The new automated beer production department of Interbrew, for instance, was the result of a process of codevelopment and comakership of the company itself with its deliverers of machinery, hardware and computer software.

The large breweries also play an important role in technology transfer in beer production. They are connected to (international) research networks, much research both on products and processes is done by themselves, and new knowledge generated in this way is transferred to other actors in direct contacts, as far as it is relevant for the specification of their own products and the improvement of the quality of their supplies. So, the breweries themselves are important sources of new knowledge for the suppliers of basic ingredients (hop farmers), the suppliers of additives and the suppliers of machinery. Consultancy services, such as provided by the Belgian farmers associations (´Boerenbond´), play a less prominent role in this regard. They are not so much concerned with new technology and innovation, but rather with business consultancy and policy issues like price policy, environmental protection, quality regulations, EU legislation and the like. Equally, the interest organizations of the Belgian breweries provide consultancy services primarily on management issues, legal affairs, environmental affairs, social affairs, tax policy and market policy issues. They do not provide consultancy services in the sphere of technology and innovation, nor do they provide training or training-related services.

In the previous chapter, we have already seen that breweries also deploy many activities in the field of training, both for youngsters/apprentices who enter the sector and for their employees. The government provides basic vocational education for agriculture and the food industry, but there are only a few vocational schools which provide specialized courses for the brewery industry. Most of these are courses for higher qualified staff positions in product development, process control and quality maintenance. Training for lower and medium qualified employees, especially further training, is provided by the breweries themselves, mostly in the form of targeted in-company courses related to specific innovations or other specific issues relevant for the companies strategies. Such courses are often developed

together with external sectoral training agencies, such as the sectoral training institute for the food and beverage sector (the IPV). Parts of their programmes might then be adjusted to the needs of the breweries and combined with internally developed modules. For these in-company training programmes other private training providers might also be hired. In the case of Interbrew, for instance, training for the new automated production department was for a large part given by the supplier of the new machinery. For quality courses, the company collaborates with the training institute of the food and drinks sector, the IPV.

So, in Belgian beer production, the large breweries are central actors in the knowledge infrastructure. As the Belgian report states, *'they are the motors in the innovation process, both regarding product and production process innovation'*. They strongly influence the generation and application of new knowledge through their own R&D efforts, they disseminate new knowledge through their contacts with suppliers of basic ingredients and production equipment and they take account of the major part of innovation-related further training of their employees and of newcomers in the sector. The role of public agencies is limited to the provision of basic vocational education and the stimulation of collaboration, where relevant, between public research and training centres with the research and training departments of the breweries.

6.7 Transfer of innovations through the knowledge infrastructure

As the previous sections demonstrate, the knowledge infrastructure in agribusiness reveals different characteristics in the different countries involved in this study. Major differences concern the degree and way of governmental regulation and intervention in research, technology transfer and training, and the degree to which developments in these fields are subjected to market forces. A common tendency, however, appears to be that the traditional model of a science-driven innovation process, strongly regulated and supported by public agencies, gradually becomes mixed up with market-driven developments in which private agencies and public-private partnerships have a stronger influence on the course of events.

As it has been argued in Chapter One, in the traditional science-driven model, innovations are usually transferred through the knowledge infrastructure in a linear way. This linear model still appears to be prominent in the product chains we have investigated, in particular in Dutch meat production, Greek cheese production and Spain's bread production. Typical for such a linear model is that different functions are distinguished regarding the production of an innovation, that the activities needed to fulfil these functions are sequentially staged in time and that clear borderlines exist between the different stages of the innovation process, e.g. the generation of new knowledge in fundamental research, the application of this new knowledge in new or better products and processes, the transfer of the new knowledge, products and processes from the research to the production system, the adoption of these innovations by the companies operating in the production system, the further dissemination

within the production system and the adaptation of qualifications to handle the new job requirements the innovations pose to management, professional staff and workers Activities in each of these stages are organized in separate institutions which operate in a rather autonomous way and are interconnected through a variety of specific linking structures. Linearity does not mean that no cyclical processes occur within the different stages of innovation. Indeed, feedback does take place in fundamental research when experiments are evaluated, or in applied research when prototypes are tested, or in the adoption phase of new products when techniques are adapted, or in the phase of qualification development when training programmes are piloted and eventually reframed to let them fit better with the needs and opportunities of their target groups. But, generally, the basic activities in the fields of knowledge generation, application and dissemination are organized in separate subsystems, divided from each other in time and place.

An example is provided by the way innovation transfer is organized in the Netherlands. Here, four categories of research (agencies) are distinguished:

- agencies for fundamental agricultural research, e.g. the agricultural faculties at universities;
- agencies for strategic applied research, e.g. disciplinary units of the government sponsored national service for agricultural research;
- there are 10 experimental stations for applied integrating research, organized per branch (e.g. pig farming); these combine fundamental and disciplinary knowledge to develop new technologies to be applied in companies;
- adaptive research, aimed at adaptation of new technologies to local circumstances; this is done at a number of regional research centres, organized per branch.

Besides these R&D-agencies, there are several types of consultancy services which act as intermediate services between R&D on the one side and the farmers and companies on the other, e.g. government related agricultural consultancy services; consultancy services related to agricultural sector organizations; private consultancy firms; and consultancy units of private companies, such as large feed and seed suppliers and the food processing companies. Equal structures for innovation and innovation transfer can be found in Greece, Spain, the UK and Belgium, although the level of institutional refinement is different, the types of institutions and their specific tasks are variant and their interconnections take up different forms. In the Greek dairy industry, for instance, the important role of public agencies for agricultural extension and development and the role of the veterinary services in the transfer of new knowledge to farmers and small businesses in the dairy industry is stressed. In Spain, subunits of the national and regional institutes for agricultural research and technology also play an important role in the transfer of technology. They also provide facilities in the field of innovation-related training. As it has been argued above, in the UK and Belgium market forces have a large impact on innovation. Here, private companies and privately sponsored institutes are major coplayers besides public authorities and the scientific community.

6.8 Role of education and training

In the linear model of innovation transfer, education and training agencies appear at the end of the line. They primarily play a role in the dissemination of knowledge, especially knowledge which has already been incorporated in products and techniques on a larger scale. They are not in the front line of the innovation process. Innovations originate in the R&D system and then become transferred to the production system. Transfer can be directly, e.g. in direct contacts between researchers and companies or indirectly through the intermediate services of consultancy agencies. Within the production system, transfer will usually take the shape of a 'cascade', as the Belgian report calls it. Such a cascade can roll through the production system in different ways. In Belgian beer production, for example, in the first instance innovations are applied in the largest companies which are involved in or connected with the R&D system; eventually, they might be modified here. Then, some of the innovations spread out and become incorporated in the products and processes of the medium-sized and smaller firms. In Greek cheese production an equal process takes place. The largest dairy industries are usually the first to come out with new milk and cheese products and to apply improved ways of milk and cheese processing and new types of equipment. Innovations might spread out then to smaller businesses and to the farmers. However, sometimes the transfer processes might also stop here, as the case of the small cheese plants in Greece demonstrates. Some of these small plants are less interested in innovations because they want to uphold traditional craft-based production systems. Others are not able to adopt the innovations because they do not have the resources or capabilities to incorporate them in their production systems. In Spain's bread production, the ´cascade´ has a somewhat different shape. Here, in the case of frozen doughs, innovation created a whole new segment on the bread market. The rise of this new segment of industrialized bread production in its turn has led to a response from the traditional bakeries. They have introduced several new bread products and have modernized their production systems in order to stay competitive.

In each of these cases, education and training primarily play a reactive, responsive role in the innovation processes. The prime goal of the education and training agencies is to adapt qualifications to the new requirements of the production system and to pass knowledge needed to deal with these new requirements on to management, workers and newcomers in the field. They usually take an average stand in their programmes while they address a broad range of workers, e.g. newcomers and are responsible for qualifying them for a wide range of applied knowledge in the first place. As far as they deal with specific innovations, this is usually done in the form of extra-curricular activities or special consultancy services directly provided to the businesses in their environment. Knowledge connected with specific innovations will only be incorporated in the basic curricula after some time when it has become part of the standard technology in the production systems. From an analytical point of view, we might say that innovation-related training usually follows the innovation cycle and will be organized in a layered system. When an innovation has just been introduced and is only applied by a small number of firms, training will mainly be taken up by private training initiatives (companies themselves, consultancy firms, R&D institutes) and will be organized

nearby the production systems itself. When the innovation spreads out and becomes applied in more products and processes, adopted by a larger number of firms, affects a larger number of occupations and, thus, influences qualification requirements of larger numbers of employees, then vocational educational institutes gradually will take over and the knowledge incorporated in the innovations will become part of the basic programmes of regular vocational education.

6.9 Development towards diversity and flexibility

As it has been demonstrated in the previous sections, the agribusiness knowledge infrastructure in the different countries involved in this study, consists of both public and private elements, which are more or less interconnected in different types of configurations. We have argued that – with regard to the investigated product chains – the spread of innovations through this infrastructure still bears many of the characteristics of a traditional science-driven innovation process with a linear transfer from the research system to the production and the educational system, regulated, organized and supported by public agencies to a greater or lesser degree. However, we have also seen that traditional configurations have come under pressure as a consequence of the modernization of agribusiness, growing international competition, growing ecological pressures and changing government policies towards agriculture and the food industry. Science-driven developments gradually become mixed up with market-driven developments in which private agencies and public-private partnerships have a stronger influence on the course of events. This tendency is particularly visible in the Netherlands, the United Kingdom and Belgium. In Greece and Spain, public authorities still have a strong foothold in the agribusiness knowledge infrastructure. However, in these countries too, private initiatives are increasingly gaining ground in the fields of innovation and innovation-related training.

In the Netherlands, the traditional model described above has come under severe pressure in the past decade. It has undergone important transformations, among others as a consequence of deregulation and decentralization of government policies, privatization of institutions, rapid (international) developments in technology and the introduction of new concepts for organizing the production and dissemination of innovations. Besides this transformation of the (semi-)public segment, the private segment of the knowledge infrastructure has risen strongly: research labs of the large agrofood industries, specialized privately financed research centres, commercial consultancy firms and private training institutes have become major players in the field. According to Dutch experts, these new realities are no longer compatible with the notions expressed in the linear innovation model.

Another pressure upon the linear model of innovation transfer comes from the rise of agrochain development and supply chain management. As especially the UK report stresses, the introduction of more market-oriented approaches in agribusiness of which the agrochain concept is an expression, have led to a reversal of processes regarding innovation in the different supply chains. The dominant actors are no longer the producers at the beginning of

the chains but the retailers, especially the large supermarkets, at the end of the chains. They are in direct contact with consumer markets, under direct pressure of shifting consumer demands and they have increasingly mobilized their power to exercise control backwards in their supply chains towards the food industries and – further backwards – towards the farmers. This shift in the power structure has led to a greater dominance of market-orientations in the innovation system. The UK report emphasizes that innovation in agribusiness is actually strongly market-driven. Among other things, supply chain management also includes the steering of innovations backwards in the chain from a quality and commercial point of view. Market demands and private interests play an important role in scientific programmes, technology transfer and training initiatives for both agriculture and the food and drinks industry.

In Belgian beer production, private interests dominate the picture already for a longer time, so market forces traditionally have a strong influence here. Especially, the large breweries have put their mark on the product chain. As a consequence of changing consumer demands and increasing competition on the beer market, they increasingly stretch out their power backwards and forwards, to influence the quality of hop farmers supplies on the one side and the quality of beer selling cafés and restaurants on the other side of the product chain. As we have seen, the breweries are also powerful actors in the knowledge infrastructure, both with regard to R&D and to technology transfer and training. A lot of this is organized by themselves according to their own criteria. With the globalization of the beer market and the increase of international competition, it is expected that the large breweries will strengthen their position in the product chain still further. It is also expected that they will have to invest more in research, product development, automation of processes, supply chain management and staff training to be able to meet shifting consumer demands and stay competitive on the world market.

Because of these trends of deregulation, commercialization, privatization and internationalization, the traditional linear model of innovation transfer has been put into question and with it the corresponding linear connected positions of research agencies, intermediate consultancy agencies and training agencies respectively. Experts point to the outgrow of different innovation models. It is expected that innovation processes will become still more subjected to market forces. Market demands will define priorities of agencies to a still greater degree and relationships between agencies will be organized more and more on the basis of market principles. Innovation processes will be less initiated in scientific circuits and then spread out to the 'market' e.g. the business community in a number of transfer processes. They will be more organized around specific problems, defined by powerful market agents who will direct the processes through continuous feedback from market developments. As a consequence, institutional borders between research, development, application, modification, dissemination and market adoption of an innovation will become further blurred. More flexible relationships will develop between the different agencies that are active in these fields. The rise of networks of companies (e.g. in supply chains) and

networks of companies and other agencies (e.g. in project organizations) is an expression of this tendency. We will elaborate this point further in the next chapter.

6.10 Resumé

In this chapter we have broadened the perspective and analysed the relationships of different agencies within the knowledge infrastructure. In agribusiness this knowledge infrastructure is usually divided into three segments: research and development agencies, agencies for technology transfer and firm consultancy and education and training agencies. Further subdivisions might be made, but these are the major categories which can be identified in the different countries in the product chains involved.

As we have seen, relationships between these agencies can be shaped in different ways depending on the influence of government regulations, national and regional traditions, market pressures and the division of power between the different institutions involved. Overlooking the arguments, we might conclude that a linear model of innovation transfer still appears to dominate the way new knowledge becomes produced and disseminated through the various parts of agribusiness. According to this model, innovations originate in the fundamental R&D circuits and are then applied and further elaborated into concrete marketable products in applied research and product development which gradually find their way to a larger number of companies, if market demand expands. New knowledge concerning these innovations is disseminated to entrepreneurs and companies by specialized agencies for technology transfer, e.g. engineering firms, regional development bodies, agricultural information services and private agricultural consultancy firms. Education and training are in this model at the end of the line. If innovations have been spread out over the production system to a larger degree, the new knowledge required to use them will gradually become incorporated into the training programmes. Firstly, in specific continuous training courses and later on, when a new technology has been broadly adopted, also in the curricula of initial vocational education.

We have also seen that the relationships between public and private agencies can be very different in the knowledge infrastructure. In Greece and Spain, public agencies play an important role both with regard to stimulation of research and development and technology transfer and education and training. In the Netherlands, the government traditionally has had a lot of influence in agricultural research, transfer of knowledge and education and training, but actually agencies in each of these fields are reorienting themselves against the background of an increasingly retiring government and a correspondingly growing influence of market forces in the agribusiness 'knowledge network'. In the United Kingdom and in Belgium (at least in the Belgian brewery sector), market forces appear to be already very influential. Here, large private companies especially the large food producers and the large supermarkets, are heavily involved in research and development, either through their own R&D departments which often run specific research programmes, or through their contacts with academic and other public R&D institutes, which collaborate in several ways with the

private sector to raise finances for fundamental and applied research. Especially in the UK, technology transfer and education and training have also become increasingly 'market-driven' as they have established many mixed public-private partnerships at local and regional levels.

Because of these trends of deregulation, commercialization and privatization, the traditional linear model of innovation transfer has been put into question and with it the corresponding linearly connected positions of research agencies, intermediate consultancy agencies and education and training agencies respectively. Experts expect a growing flexibility and diversity of relations within the knowledge infrastructure. Innovation processes will increasingly become subjected to market forces and relationships between agencies will increasingly be organized on the basis of market principles. As a consequence, traditional institutional borders between research, development, application, modification, dissemination and market adoption of innovations will become further blurred. Experts expect that alliances in the form of networks (between companies, between companies and R&D agencies, between companies and training agencies, between private and public agencies) are going to play an important role in the knowledge infrastructure in the future.

7. ROLE OF NETWORKS IN INNOVATION AND TRAINING

The relationships between innovation and training and the role sectoral training agencies play in mediating these relationships have a central place in this study. In Chapter 5 we have argued that training at sectoral level is only part of the game and that training at the level of companies and company networks also plays an important role with regard to the adaptation of qualifications in agribusiness. Furthermore, in Chapter 6 we have concluded that collaborative relationships and networks of agencies are not only relevant for training but also they tend to become more important with regard to innovation and the transfer of innovations in the knowledge infrastructure as a whole. In this chapter, we will examine the role of networks in innovation and training a little bit further in order to demonstrate how an analysis from a network point of view can add value to a purely sectoral approach to training. Within the framework of this study, this analysis can only be an explorative one. An elaboration of the notions to be developed in this chapter requires further in-depth research.

7.1 Innovation networks and learning networks

The concept of a 'network' as we use it in this chapter can be conceived of as a social mechanism through which different actors with different positions and different interests coordinate their activities to reach commonly shared objectives or solve commonly shared problems. Within the frame of a network the actors might undertake different types of activities and bring in different types of resources. The scope, degree and durability of coordination might be variant and an essential point is that social actors collaborate in a certain way from a common perspective according to a commonly defined set of rules. With these notions, we follow certain recent elaborations of the network concept in social-economic theory (see Hakanson, 1987; Oerlemans, 1996; Kickert e.a., 1997).

Recently, Van der Krogt has undertaken an interesting attempt to use a network approach in the field of education, training and learning (Van der Krogt, 1995). He introduces the concept of 'learning networks' to describe and analyse collaborative initiatives of social actors (persons, agencies, bodies) who in one way or another contribute to the development of qualifications. He uses the term 'learning' and not 'training' to point to the fact that development of qualifications can be organized in very different ways. Not only in formal ways, with an external 'pedagogical instance' (i.e. teacher) guiding and steering the learning processes (such as in vocational educational programmes or in training courses), but also in more informal ways, in which learning processes are embedded in other processes (i.e. work) and are guided and steered by the learners themselves (such as in situated learning, action learning, learning by doing). Learning networks provide an institutional framework within which the actors involved can jointly organize the activities needed to generate learning processes. According to Van der Krogt, basic activities in learning networks are: the shaping

of a learning policy, the development of learning programmes and the execution of the learning activities. Training agencies often have a central place in learning networks, but this does not necessarily need to be the case (Van der Krogt & Warmerdam, 1997).

In the same way as learning is looked upon from this point of view, we might look upon innovation as – for a part – taking place within networks. Innovation networks might then be conceived of as joint initiatives of different actors who undertake different activities and bring in different resources to reach a common objective, e.g. the production and dissemination of an innovation. Activities can be aimed at new products and processes, improvement of existing products and processes, new or better production equipment and machinery and new or better organizational and managerial systems. All these types of innovations are relevant in agribusiness at the moment as we have seen in the previous chapters. If we carry the analogy with learning networks still further, we might say that basic activities within innovation networks are the shaping of an innovation policy, the development of

innovation programmes and the execution of the innovation activities themselves. Often, research institutes will have a central place in innovation networks, but they are surely not the only relevant actors. Especially when it comes to the concrete incorporation of innovations in production systems, several other actors might play an important role.

7.2 Relationships between innovation networks and learning networks

Particularly relevant for the purpose of this study are the relationships between innovation networks and learning/training networks. In practice, these relationships can be shaped in a variety of ways. Mainly, four 'ideal typical' forms can be identified (cf. Van der Krogt, 1995; Hôvels & Romeijn, 1998):

- the innovation network and the learning network are fully separated and operate fully independently from each other; there are no links between them; there is in fact no relationship at all;
- the innovation network and the learning network operate as separated networks but they are interconnected through specific communication channels;
- the innovation network and the learning network partially overlap each other; certain actors are part of both the innovation and the learning network;
- the innovation network and the learning network fully overlap each other; there is in fact no distinction between innovation and learning; both are different aspects of one and the same set of activities.

We might say that the more the two networks are integrated, the less innovation and learning processes can be separated with regard to time and location. When the two networks are clearly disconnected, learning activities might be staged at other moments in time and

situated at other locations then those where the innovation activities take place. The more they become connected, the less these possibilities for sequencing and distancing of learning activities will be. In the utmost case, if the two networks are fully integrated, the activities fall together. Innovating is learning and learning is innovating. Both processes become intermingled within one and the same flow of activities.

We will illustrate these arguments now with some examples from the national reports. Beforehand, we might say that a general conclusion can be that in all the investigated product chains an institutional separation of innovation and learning/training appears to be the dominant model. Especially in the case of fundamental innovations, e.g. innovations which affect basic technologies and have far reaching consequences for a wide range of products and processes, training and learning are usually organized in separate institutional contexts. In the linear innovation model which is rather dominant as we have seen, separation of innovation and learning processes is dominant. Usually, learning is reactive in the sense that it follows specific innovations. In the cyclical innovation models, separation of innovation and learning is less prominent. Here, interlinks might be established and sometimes a certain overlap of networks is visible.

The national reports describe several examples of networking.

In the United Kingdom, for instance, the government stimulates networking through the *LINK scheme*: a scheme in which the government collaborates in the funding of industrially relevant research in agrofood areas. As the report states, the principal objectives are: *'to enable and accelerate the commercial exploitation of technology leading to new products, processes, systems and services; to promote close interaction between industry and the research base, so that nationally supported programmes of basic research are influenced by the awareness of the needs of the industry; and to stimulate industry to increase its own investment in research*. The LINK programme promotes partnerships between industry and research establishments and is concerned with pre-competitive research. Many important agrofood areas, like for instance food processing, agrofood quality, hygienic food manufacturing and sustainable livestock systems, are covered by the scheme. LINK participants benefit from involvement in an active focused network, the UK report states: *'The industry partners gain access to high quality researchers whose science can underpin innovation in a company. The science based researchers are able to work with industry and apply their knowledge to research with commercial potential.* The provision of training is not included explicitly in the scheme. However, information regarding these programmes is disseminated in a number of other ways, like seminars, conferences, newsletters and roadshows to demonstrate new findings at location. A recent independent evaluation has assessed the LINK scheme as a successful practice for interlinking the research and business community.

Another interesting example from the UK is the *regional food technology transfer centres* which have been developed in recent years under the commission of the UK government. The goal of these centres is *'to stimulate increased awareness and uptake of modern food technology by SMEs by strengthening the links between food manufacturers and local academic centres of expertise'*. The centres should act as gateways for technology input to

the local community and as training providers. As the UK report states, the regional centres have a specific strategic approach: '*They provide a single point of contact for SMEs with food related consultancy needs. The emphasis is on disseminating the vast array of knowledge and research held within the academic partners of the centres, providing development support, training, undertaking contract research and consultancy. They have also established corporate membership schemes for companies within their geographical area. Thus it is hoped to provide a framework within which the companies immediate needs can be met, allowing them to be more receptive to innovative concepts*'. Development of applied knowledge, knowledge transfer and learning while experimenting appear to go hand in hand in the activities of these centres.

An example from the Netherlands is the activities of the *Stichting Agro Keten Kennis* (AKK; agro chain knowledge), a fund for the financing of collaborative projects, especially aimed at strengthening the knowledge infrastructure within specific product chains. Collaboration between public and private agencies is a precondition for the funding of projects. The projects cover most of the important agribusiness branches, like grains, fruit and vegetables, meat products, dairy products and fishery. Four thematic fields are distinguished, all related to product chain management: chain differentiation, integrated chain quality care, chain optimalization and chain knowledge dissemination. In addition, projects might be submitted in four 'chain knowledge areas': strategy and organization, management, marketing and agro-logistics. AKK further initiates a number of long-term research programmes based on public-private collaboration in which it plays the role of change agent, initiator, facilitator and mobilizer of adequate expertise. All kinds of institutes may participate in AKK projects: R&D agencies, companies, local authorities and training institutes. In the meat sector, for instance, a project has recently been designed to assess the basic factors which influence the image of pig meat quality. In this project, both employers and Wageningen University participated. Recently AKK and STOAS, an important training institute in Dutch agriculture, have started a collaboration to look at the implications of chain management for qualifications and training in agricultural vocational education.

Another example from the Netherlands is the '*innovation creating networks*', envisaged by the Dutch research institute NRLO to come into existence in Dutch agribusiness in the future. We have mentioned these already in previous sections. As expected by experts, these networks will evolve around certain basic challenges in Dutch agribusiness, such as agrochains and logistics, conservation and improvement of ecological quality, animal health care strategies and integrated livestock production systems. Expertise will be mobilized from a variety of disciplines and institutions and the networks will explicitly be designed to cross existing institutional borders. A basic philosophy behind this network concept is the idea of opening up traditional one-sided perspectives and bringing agencies from different institutional fields together to look for commonly shared strategies to tackle interdisciplinary problems. Recently, discussion started between the research community and the agricultural training agencies to elaborate the implications of the expected developments for the content and organization of agricultural vocational education.

A final example we want to mention are the *regional networks* which exist within and around the dairy produce sector in the region of Ipiros/Greece. Focal points in these networks are the Dodoni dairy industry, the Dairy Food Research Institute and the Agricultural Vocational School. In the course of years, many mutual collaborative relationships have been developed between these agencies and between them and local authorities responsible for regional agricultural development. Information about new procedures and technologies, such as new regulations for sheep and goat breeding, new hygienic and quality rules, new techniques for improving the quality of milk and milk-based products, new milking machinery, new storage and transportation techniques, etc. are transferred through these networks in a rather direct way to the breeders and the milk and cheese plants. As we have described in the previous section, the Dodoni company organizes its own network of milk suppliers and plays an important role as a provider of training within this regional network.

The examples described above demonstrate that, in agribusiness, the network level is clearly relevant for learning in relation to innovation. It appears it will become even more relevant in the future. In a broader sense, we might say that innovation-related learning forms one of the spear points in the interconnection between the production and the education systems. In the first instance, innovations as concrete expressions of technological developments give rise to specific learning activities which are closely connected to or even embedded within the production system itself. These embedded learning activities which are often of a less formal kind can be considered as the first response of the educational system to new requirements related to new technologies. At later stages, when innovations become wider disseminated within the (broader) production system, corresponding learning activities will gradually become incorporated in the curricula of the (broader) formal vocational education systems.

7.3 Sectoral training agencies and innovation and learning networks

As we have seen in the previous sections, the level of networks is clearly relevant for the organization of training and learning, especially with regard to new technology. We might conclude that a sectoral approach to training is limited in the sense that it only covers part of the learning processes related to new technology. It should be completed by a network approach which can take activities at company and inter-company level into account. A crucial question is the interlinks between the sectoral and network levels. How can sectoral training initiatives be connected with initiatives at inter- and intracompany level? Which role can sectoral training agencies play in relation to innovation and learning networks?

Concrete opportunities of sectoral training agencies will be dependent upon the exact nature of the innovation and learning networks and upon the way these are interconnected. In general, however, we can distinguish five different roles sectoral training agencies might play:

- In the first place, sectoral training agencies might *initiate* the building of networks at company level. The starting points for network building might be very different and might

vary from sector to sector. For instance, networks might start when sectoral training or consultancy agencies organize periodic meetings for small farmers and businesses to give them information about new legislation, new government policies or new technologies in the field. We find examples of such networking among small firms in Greek milk and cheese production. The networks might also be initiated by bringing businesses with the same kind of technical equipment and installations in contact with each other in order to exchange information about equipment use, handling and maintenance, etc. As the Greek milk sector and the Belgian beer sector demonstrate, deliverers of machinery might become partners in such networks. Another way of starting a network can be through contacts with former students. Training agencies can call them back and group them together, e.g. for refresher courses or dissemination of new production methods. Networks can also start on the basis of information, consultancy and training services for established entrepreneurs. As the case of the Netherlands shows, more permanent 'study circles' can grow from groups of entrepreneurs brought together to exchange information or to demonstrate new types of equipment.

- Secondly, sectoral training agencies might act as a *broker* between organizations who have an interest in establishing a network. The basis of these interests might be very different. Usually, benefiting from new market opportunities, sharing certain collective resources and opposing threats from outside the branch are major factors stimulating inter-company collaboration. But the opportunity of getting access to new knowledge and learning about new technologies might also be a stimulus for companies to participate in exchange relationships with other companies and with providers of new knowledge and technology. A sectoral training agency can stress these common interests and can try to act as a catalyst in organizing mutual exchange between the users and producers of new knowledge and technology. In the Netherlands, a discussion is going on about the possible role of sectoral organizations as technology intermediaries between the scientific and the business communities. In several sectors, like the installation branch and the car repair sector, sectoral training institutes have already presented themselves as a kind of 'knowledge centre' for their branches, covering not only training but also tasks in the field of technology transfer and implementation of new technology. In the agribusiness sector, as yet, this is not the case. But through their brokerage activities, sectoral training agencies are trying to get a more central place in the knowledge infrastructure.
- Third, sectoral training agencies might participate as a *partner* in private company networks or in mixed public/private partnerships. As the national reports demonstrate, especially research and development becomes increasingly organized in joint networks or joint projects. In Greece and Spain, local authorities together with larger companies work together in developing these networks. In Belgium, the Netherlands and the United Kingdom, private companies appear to have a more prominent role in establishing these joint initiatives. Sectoral training agencies are not always involved in these initiatives, however, and, when involved, their role appears to be limited. They usually provide information services regarding the innovations envisaged. Or they might bring in their

training staff to design specific training programmes targeted at certain types of (new) work or certain categories of workers (potential users of new technology). Sometimes, the training agencies are particularly called in because of the social implications of certain innovations. In such cases, their contribution focuses on the training and retraining of workers (and entrepreneurs!!) becoming redundant as a consequence of new technology and the corresponding restructuration of the production system.

- In principle, sectoral training agencies could also take up the role of *director* of a network. In actual practice, however, this seldom appears to be the case. In the national studies, no situations were reported where sectoral training agencies really took the lead, neither regarding innovation nor with regard to learning networks. Innovation networks are usually managed by representatives of larger R&D institutes or larger companies. Sometimes a steering committee or a coordination group is established in which representatives of training institutes also have a seat. In learning networks, the role of training agencies is more prominent as can be expected. Agricultural schools or other sectoral training institutes can be the focal points in networks of former students or local entrepreneurs, as we have seen in the Greek dairy industry. However, as this example also demonstrates (as well as the example of the Belgian beer industry), a dominant company in a certain region might also fulfil this coordinating role.
- Finally, sectoral training agencies might also take a more distant stand and merely act as a kind of *facilitator* towards company and intercompany networks. In such a role they could provide information about available training programmes or training funds which might be relevant for networks. Or they could gather information about (regional) experiences with networking and learning in networks and disseminate this information to other interested parties within and around the sector. They also might undertake activities to monitor and assure the quality of training and learning activities in company networks, for instance by introducing certification procedures or systems for the assessment and recognition of non-formal learning.

If we look over the information in the national reports, we might conclude that the involvement of sectoral training agencies in agribusiness innovation and learning networks is rather limited. In some cases, this has to do with a lack of organization at sectoral level. Where specific sectoral training agencies have not been established, private companies and partnerships take the lead. In other cases, it has to do with the relationships between the established sectoral agencies and other players in the field. Innovation networks in particular are usually dominated by large R&D institutes and/or large companies and as far as these have established collaborative relationships with agricultural training institutes it is usually in the field of academic and higher education. Relationships with medium-level secondary schools and apprenticeship training institutes have been seldom established. There are indications that it is difficult for these agencies to find an entrance to specific innovation and learning networks organized within the business community itself. However, it might also be a conscious policy of sectoral training agencies to keep a certain distance from networks and other initiatives at private company level. For a long time, as the UK and Dutch reports clearly

state, vocational training agencies have primarily oriented themselves towards their public duties and have considered themselves to be primarily responsible for basic initial vocational education. As such, they were primarily part of the educational system. Continuous training was looked upon as part of the production system itself and left to 'the market'. With the rise of continuous training and related discussions on lifelong learning, this situation is changing both in the UK and the Netherlands. Vocational schools and sectoral training agencies increasingly orient themselves towards the business community as a partner in the shaping of adequate training and learning provisions. In the long run, sectoral agencies could particularly become a more important player in two fields. Firstly, they could become a more important partner in (existing) agricultural learning networks. Secondly, they could play a more important role in the connection of learning networks with innovation networks, especially in situations where innovation and learning networks become more integrated. In the innovation networks themselves, especially those for fundamental innovation, they probably will tend to stay at a distance. In these networks, R&D institutes and larger companies will remain the major actors.

7.4 Relevant aspects of the functioning of innovation and learning networks

Because we can expect innovation and learning networks (and more integrated forms of both) to become more important in the future as mechanisms for the coordination of policies and activities of different actors in agribusiness, we want to conclude this section with a discussion on some aspects of networks which, in our view, deserve special attention in future research. Knowledge about the actual functioning of networks in the field of innovation and learning is rather scarce at the moment. More in-depth insight into these new phenomena could benefit the development of training policies, not only at sectoral level but also at national and regional levels. Further research need not be limited to agribusiness. In other sectors, tendencies towards the development of networks appear to become stronger as well. These experiences might also provide useful information.

A first suggestion for further research concerns the *internal conditions* of networks, e.g. their structure and functioning. Questions could be raised such as: Who participates in the networks? What are the motives and interests of participants for joining the networks? How are the different interests adjusted to each other? Which common interests and goals have been identified? How has consensus about common interests been reached? How is the network organized? What are the roles and tasks of the different participants? Who has what kind of responsibilities? Which procedures for internal communication have been elaborated? Studying such questions in actual networks can provide relevant information about conditions for effective network organization.

A second relevant aspect concerns the *external relationships* of networks, in particular the relationships with the political environment (education system) and the economic environment

(production system) in which they are embedded. Who are the relevant external 'stakeholders'? How is communication with these stakeholders organized? How is feedback between network activities and activities of the 'home bases' of the participants provided? How can adequate input from these 'home bases' into the network be guaranteed? How can the results of network activities be communicated to the environment? Studying these questions in innovation and learning networks could reveal relevant insights into their meaning and function for broader education and production systems.

A third point concerns the *coordination or management* of the networks. Networks are different types of organizations from classical bureaucracies which were the model for many institutions in the field of research, development and education. This new organizational form requires new types of co-ordination and management. Despite the differences between different types of networks, one might say networks presume a more symmetrical relationship between participating organizations than classical bureaucracies do. Power is more divided throughout the network, relationships are more balanced. How can management be organized within such a context? Which kind of decision making procedures are adequate? Which tools and instruments are available for coordinating agents to steer a network in the desired direction? Recent network literature has already revealed relevant insights (cf. Kickert, 1997).

A very relevant aspect is also the *dynamic* of networks. For practitioners in the field, an important question is often: how to start a network? What are the prerequisites for a successful start of the network? But, once established, a network has to be kept alive. Because there are always inherent tensions between the common interest of the network as a whole versus the individual interests of the participating organizations, certain ways of dealing with these tensions have to be developed. Which solutions have been found in practice? Furthermore, it is known that networks can change their organization and operational procedures during their existence. Could something be said about the way they tend to develop? Recent network literature already gives some suggestions for further research. Van der Krogt (1995), for instance, has elaborated a specific model for the description and analysis of the dynamics of learning networks. He distinguishes four basic tendencies within learning networks: (a) strengthening the vertical/hierarchical dimension of networks through the stimulation of central planning, rules and regulations and management instruments, etc.; (b) strengthening the horizontal dimension of the networks through stimulation of mutual exchange, shared visions, common perceptions of how to operate, etc.; (c) strengthening the professional dimension of networks through the introduction of external training agencies, professional consultancy, connections with professional bodies, etc.; and (d) doing nothing at all and in this sense developing the network in as 'liberal' a way as possible. We think this model could be an interesting starting point for more in-depth research into the development of existing learning networks.

A final aspect we want to mention concerns several *new roles or functions* which appear to come into existence in relation to the development of networks. For instance, one can think of roles or functions like: the network initiator, e.g. the person who takes the actual initiative to

build up a network, mobilizes the necessary resources and looks for the conditions for a successful start; the broker, e.g. the person who brings the participants together and looks for an adequate balancing of individual and common interests; the network manager, e.g. the person who keeps the network going, develops shared visions and perceptions, deals with specific tensions and tries to steer network activities in the desired direction; and the gatekeeper, e.g. the person who takes care of the relationships with the environment and looks after in- and outgoing communications. A very relevant question is how these roles can be filled in innovation and learning networks, especially in more integrated forms. Another relevant question is what kind of qualifications would be required from persons fulfilling these roles in such networks. A final question would be whether or not these roles will grow into new jobs or new occupational profiles when networks become more predominant in the relationship between education and work.

In this section we have only been able to touch on these questions. To answer them would clearly exceed the possibilities of this study. In our view, it would be very relevant to conduct further investigations into the opportunities and limitations of networking in the field of innovation and training. This study in the agribusiness complex has demonstrated that besides the sectoral level, the level of networks is also increasingly relevant for the organization of continuous training and learning activities. Company networks, intercompany networks and networks of companies with other agencies appear to become essential links in the chain which connects education and production systems. Many authors have stressed the fact that networks will become a major mechanism of social coordination in the future, besides more traditional mechanisms like markets and hierarchies – see for instance Castell's (1997) notion of the rise of 'network society'. This tendency which might also have far reaching implications for education and training, should be monitored by adequate research.

7.5 Resumé

Because of the important role networks are expected to play in agribusiness knowledge infrastructure in the future, we have devoted the final chapter of the report to elaborate some relevant aspects of this phenomenon. We have defined networks as social mechanisms through which different actors with different positions and different interests coordinate their activities to reach commonly shared objectives or solve commonly shared problems. Within the frame of a network, actors might undertake different types of activities and bring in different types of resources.

Furthermore, we have distinguished 'innovation networks' and 'learning networks'. We have argued that these two types of networks might be related in four different ways: innovation and learning networks might be fully separated and operate independently, without any links; they might operate as separate networks but be connected through specific communication channels; they might partially overlap each other because certain actors operate in both networks; and they might be fully integrated, e.g. when innovation and learning are both

aspects of one and the same flow of activities. Several examples of these kinds of networks and the interlinks between them were elaborated on the basis of information from the national reports: the LINK scheme to support collaboration between the scientific and business communities in the UK; the regional food technology transfer centres in the UK; a Dutch fund for the stimulation of collaborative projects in the field of knowledge creation and dissemination at the level of specific product chains; and the example of 'innovation creating networks' envisaged by experts to become focal points for innovation and learning in Dutch agribusiness in future.

Next, we have discussed the possible role of sectoral training agencies with regard to innovation and training networks. We have elaborated five different types of roles: sectoral training agencies might initiate the building of networks at company level; they might act as a broker between organizations who have an interest in establishing a network; they might participate as a partner in private company networks or in mixed public/private partnerships; they could also take up the role of director of a network; and, finally, they might also take a more distant stand and merely act as a kind of facilitator towards company and intercompany networks. We have concluded that actually, the role of sectoral training agencies in innovation and training networks is rather limited. It is expected, however, that this might change with the rise of continuous training and lifelong learning in future.

Finally, we have elaborated some suggestions for possible future research in the field of innovation and learning networks. Four areas have been identified as particularly relevant for further study: the internal conditions of networks, e.g. their structure and functioning; the external relations of the networks, e.g. the way they organize communication with their political and economic environment; the question of management and coordination of networks; the question of network dynamics; and, finally, the new roles, functions and qualifications which might develop as networks become an important form for organizing innovation and learning activities.

8. SUMMARY

This synthesis report which was written on behalf of CEDEFOP within the framework of the CIRETOQ network, focuses on innovation and training in the agribusiness complex. Carrying further earlier research work into the opportunities and limitations of a sector approach to training, it has as three major objectives (a) to provide more in-depth insight into the relationship between innovation and qualification in various parts of the agribusiness complex in various countries, (b) to give a picture of the role of training agencies and other sectoral agencies in the transfer of innovations and the adaptation of qualifications, and (c) to give an assessment of the opportunities and limitations of a sector approach to training when applied in a field subjected to rapid technological change and economic restructuration.

For the purpose of the study five national reports were composed, each focusing on a specific product chain in agribusiness:

- the beer production chain in Belgium;
- the cheese production chain in Greece;
- the bread production chain in Spain;
- the vegetable production chain in the United Kingdom;
- the meat production chain in the Netherlands.

In this chapter, we summarize the main findings and arguments of the study. Five basic issues are addressed: the concrete innovations in the investigated product chains, the impact of innovations on qualifications, the role of sectoral agencies in innovation-related training, the relationship between research, technology transfer and training within the broader knowledge infrastructure and the role of networks in innovation and training.

Innovation in the investigated product chains

There are remarkable differences between the investigated product chains with regard to innovation and its implications for the actors involved. Differences regarding innovation have to do with different national traditions, different technological, economical and sociocultural environments, different structural positions and different relationships between the major actors in the product chains. Also the primary driving forces behind innovation appear to be different in the different countries/product chains:

- in Belgian beer production, (international) competition together with organizational efficiency appear to be major drives to innovate production systems;
- in Greek cheese production, a combination of push-factors from science and technology, government legislation and support schemes and the establishment of industrial agrofood industries appear to have had major effects;

- in Spain's bread production, the concentration process and the resulting economies of scale, the import of new products from abroad and the establishment of modern industrial bakeries have had an innovative effect on the sector as a whole;
- innovation in the vegetable production sector in the United Kingdom is strongly influenced by market trends and changes in consumer demands towards more quality products;
- in the Dutch meat production sector, besides strong market influences, ecological pressures and government actions towards economic restructuring are strong drives for innovation.

However, despite the differences, striking similarities become visible. One important similarity is for instance the relationship between quality improvement and technological innovation which becomes visible in all the investigated sectors. Many innovations have at least as a consequence that quality aspects of production, processing and distribution become more to the front in the different product chains. Secondly, the strengthening of relationships between different actors within the chains is a clear similarity, whether or not this is explicitly organized under the parapet of supply chain management. There are differences in the power structures within the chains. Sometimes the supermarkets are dominant, like in salad production in the UK. Sometimes the processing companies are dominant, like in beer production in Belgium and cheese production in Greece. And sometimes retailers and processors are rather balanced, like in bread production in Spain and meat production in the Netherlands. In every country/sector, however, a tendency towards a reversal of chain dominance appears to take place. Everywhere, power is shifting away from the producers towards the consumers' end of the line.

The impact of innovation on qualifications

If we look upon the arguments which have been put forward in the national reports, we might conclude that qualifications in agribusiness are clearly affected by innovations, but that the degree of impact is different in the different segments of the product chains. The most severe impact is visible in food processing companies. Here, qualification requirements are generally rising. More product and process knowledge is required, more analytical skills are required, more in-depth knowledge of mechanical and electronical aspects of the equipment is asked for by companies. In addition, new skills in fields like quality control and monitoring are added to the profiles of production workers. Sometimes new types of jobs have been introduced in these companies which require higher levels of formal education, such as the jobs of process operator, line supervisor, quality controller and lab researcher. However, many innovations are also incorporated through an extension of existing jobs and qualification profiles with new elements, such as in fields like quality assurance, maintenance, monitoring and communication.

The impact of innovations on qualifications at the beginning stages of the chains – the farms – appears to be less intense. Here also, additional knowledge is required, but it is a kind of knowledge which is in line with the cultivation and processing knowledge already available at

many farms. Usually, further training could be built on this existing knowledge basis. However, in a case of rapid modernization, like in sheep farming in Greece, such strategy no longer appears to be sufficient. Here, a more fundamental strategy has to be followed. In Greece, a combination of regional development programmes, new education and training provisions and specialized agricultural consultancy services was used to qualify farmers to cope with the requirements of new technologies, markets and legislative demands.

At the end of the chain in the food retail trade, innovations appear to have had relatively the least impact on qualifications. Here, new requirements in fields like customer orientedness, information and communication and sales skills are usually incorporated into existing job profiles. Only in some sectors and some larger companies special new logistic competences have crystallized into a new occupational profile, usually covered by the label of 'supply chain manager'.

Sectoral training agencies and innovation-related training

Resuming the findings and arguments in the national studies, we might conclude that agribusiness is 'sectoralized' to a lesser degree than many other segments of the economy, not only in the field of education and training, but also with regard to industrial relations, collective bargaining, trade union organization, social partnership and employment and labour market policies. Partly, this is due to the great heterogeneity of the different segments of agribusiness (agricultural production, food processing industry, food retail trade). Partly, it has to do with the tradition – in many countries – of strong government regulation and protection in this field. One might say that under the umbrella of government regulation there was less need for selfregulating mechanisms to be developed by the business community itself. Collective organization is weak, particularly on the workers side. Social partnership is less developed. Joint arrangements and institutions have found less fruitful soil than other segments of the economy. However, in some instances, as we have seen, sectoral initiatives in the field of training have taken off during the past decades. In Spain these are union-led, in the UK they are employer-led, in the Netherlands they are organized on a joint basis. If we look at all the evidence in the national reports, however, we must conclude that examples of joint initiatives of the social partners are rather scarce in agribusiness.

Where collective, sectoral initiatives in training have been less developed, private initiatives come into the picture, the national reports clearly demonstrate. We have discussed the most important ones and have given concrete examples from the national studies. Private companies themselves are often major providers of continuing training for workers, in particular the large food companies. In addition, networks of companies and networks of entrepreneurs might play an important role. Especially in the food industry, supplier-manufacturer networks offer opportunities for organizing training and learning processes. In agricultural production, formal and informal networks of farmers and breeders provide opportunities for information exchange, mutual consultancy and more formalized training sessions.

We have also concluded that thinking in terms of 'agrochains', which is actually strongly promoted for economical and commercial reasons (see the UK and Dutch reports) can provide opportunities to overcome some of the disadvantages connected with the actual institutional segmentation in agribusiness. Product chains cross existing institutional domains and might provide companies from different segments with a common interest to build training activities upon. However, a too rigid organization in terms of product chains might also impede adequate training because it runs the risk of qualifying people for a too narrow strand of work. In order to prevent such 'overspecialization', several experts propose to take the broader notion of 'networks' as the basis for the organization of training activities.

The knowledge infrastructure in agribusiness

In the next step of the study, we have broadened the perspective and analysed the relationships of different agencies within the 'knowledge infrastructure'. In agribusiness this knowledge infrastructure is usually divided into three segments: research and development agencies, agencies for technology transfer and firm consultancy and education and training agencies. Further subdivisions might be made, but these are the major categories which can be identified in the different countries/product chains involved.

As we have seen, the relationships between these agencies can be shaped in different ways depending on the influence of government regulations, national and regional traditions, market pressures and the division of power between the different institutions involved. Looking at the arguments, we might conclude that a linear model of innovation transfer still appears to dominate the way new knowledge becomes produced and disseminated through the various parts of agribusiness. According to this model, innovations originate in fundamental R&D circuits and are then applied and further elaborated into concrete marketable products in applied research and product development and gradually find their way to a larger number of companies, if market demand expands. New knowledge concerning these innovations is disseminated to entrepreneurs and companies by specialized agencies for technology transfer, e.g. engineering firms, regional development bodies, agricultural information services and private agricultural consultancy firms. Education and training are in this model at the end of the line. If innovations have been spread out over the production system to a larger degree, the new knowledge required to use them will gradually become incorporated into the training programmes – firstly, in specific continuous training courses and later on, when a new technology has been broadly adopted, also into the curricula of initial vocational education.

We have also seen that the relationships between public and private agencies can be very different in the knowledge infrastructure. In Greece and Spain, public agencies play an important role, both with regard to stimulation of research and development and technology transfer and education and training. In the Netherlands, the government traditionally has had a lot of influence in agricultural research, transfer of knowledge and education and training, but actually agencies in each of these fields are reorienting themselves against the background of an increasingly retiring government and a correspondingly growing influence

of market forces in the agribusiness 'knowledge network'. In the United Kingdom and in Belgium (at least in the Belgian brewery sector) market forces appear to be already very influential. Here, large private companies, especially the large food producers and the large supermarkets, are heavily involved in research and development, either through their own R&D departments which often run specific research programmes, or through their contacts with academic and other public R&D institutes which collaborate in several ways with the private sector to raise finances for fundamental and applied research. Especially in the UK, technology transfer and education and training have also become increasingly 'market-driven', as they have established many mixed public-private partnerships at local and regional levels.

Because of these trends of deregulation, commercialization and privatization, the traditional linear model of innovation transfer has been put into question and with it the corresponding linearly connected positions of research agencies, intermediate consultancy agencies and education and training agencies respectively. Experts expect a growing flexibility and diversity of relations within the knowledge infrastructure. Innovation processes will increasingly become subject to market forces and relationships between agencies will increasingly be organized on the basis of market principles. As a consequence, traditional institutional borders between research, development, application, modification, dissemination and market adoption of innovations will become further blurred. Experts expect that alliances in the form of networks (between companies, between companies and R&D agencies, between companies and training agencies, between private and public agencies) are going to play an important role in the knowledge infrastructure in future.

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ISBN 92-828-8366-3

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